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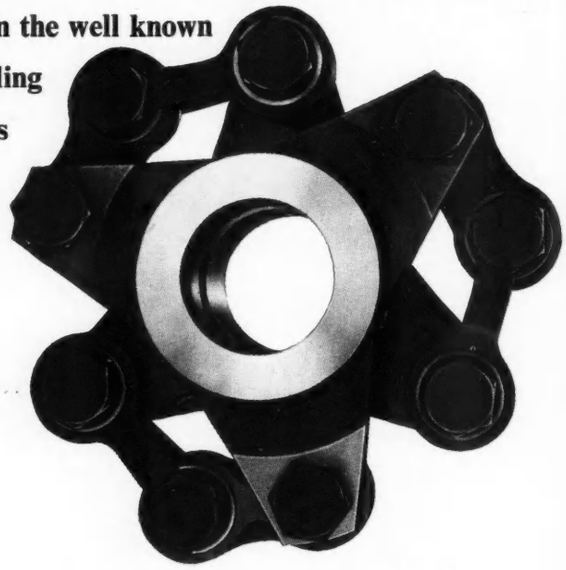

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BRICKS WITHOUT STRAW?

NOWADAYS, bricks can be made without straw, but little can be made without men; what is more, in this industrial age the men must be equipped with skill and knowledge. Of the three economic factors of production, land, labour and capital, labour of the right quality and quantity is the one most frequently neglected in planning of projects. It is useless to make plans if there are insufficient men to carry them out, and now that the long-predicted shortage of scientific man-power is taking effect, it is necessary to ask: have we undertaken more than we can achieve? Or have we failed to make best use of the technologists available? The dilemma, however, remains; to survive as an industrial nation Britain must carry out the important developments planned, yet to proceed with them may stretch our man-power resources to breaking point.

This problem was by no means unforeseen. Almost ten years ago, a committee was appointed under Sir Alan Barlow, to "consider the policies which should govern the use and development of our scientific man-power and resources during the next ten years. . . ." In its report the committee estimated that by 1955 the demand for scientists would be in the region of 90,000, but that under plans existing at the time the report was submitted not more than 64,000 would be available. The Barlow Committee therefore suggested that "the immediate aim should be to double the present output, giving us roughly 5,000 newly qualified scientists per annum at the earliest possible moment."

By 1947 the doubling of university output of scientists had been virtually accomplished, but it was concluded therefore that there could be no further increase without a reduction of standards. This rapid increase was of course largely due to the influx of ex-servicemen into universities—in 1947, the number of associate members elected to the Institution of Mechanical Engineers was also more than twice that in any other year, before or since—but the universities managed, apart from small declines, to maintain their output. To-day, there are approximately 80,000 full-time students as distinct from 40,000 to 50,000 pre-war. However, the number of arts students rose in proportion, and only some 12 per cent. or about 10,000 are reading technology and 17,000 pure science.

Yet in spite of the increase, which is of the order proposed by the Barlow Committee, the problem still exists. The main reason is that in spite of the success of the universities in stabilising their output at twice the pre-war number within four years, demand for scientifically and technologically qualified people has risen to many times its pre-war value. The boom in engineering industry has played its part in this; the development of new industrial fields, nuclear energy for example, and high-speed flight, have also contributed. Moreover, plans for road and rail improvements, and the Central Electricity Authority's power-station programme will tax our resources still further in the future. It is interesting to note that the number of university students in residence rose during last year by 1,108, of which technology accounted for 696 and pure science for 314; however, at the same time the United Kingdom Atomic Energy Authority has set up research laboratories with a scientific and experimental complement of 800. Thus, at one gobble the larger part of the increment is swallowed.

In what way does the shortage affect industry? The Professional Engineers Appointments Bureau, like other similar organisations, finds that many more vacancies are notified by employers than can possibly be filled, with the result that firms compete with each other for qualified men, who tend, therefore, to move from job to job at a rate that benefits nobody. Small firms without extensive training schemes and providing only a narrow specialised experience suffer most. This state of affairs is often exacerbated by the simultaneous existence of vacancies and unsatisfied applicants, a situation caused by applicants demanding a higher salary than their qualifications and experience merit and by employers seeking ability in excess of what a particular job requires.

This over-estimation of needs may suggest a partial solution to the shortage problem. Firms which at present do not hesitate to select a graduate might find that an applicant with a Higher National Certificate would serve their purpose equally well. A man who obtains this qualification by evening study is certainly equipped with stamina, and 60 per cent. of the new membership of the Institution of Mechanical Engineers have entered by this route. Moreover, during the period 1945 to 1954 the total number of Higher National Certificates already awarded had risen from about 13,000 to nearly 37,000. Another approach to the shortage is to encourage a greater proportion of university students to read scientific subjects.

We live in an industrial age and cannot afford to fall behind; this warning has so often been repeated that its edge has been blunted, but we must remember that there are only two alternatives: to abandon the schemes on which our future depends, or to find the men who can put them into practice.

Weekly Survey

Cover Picture. *Hunter interceptor fighters are now flowing rapidly into service with Royal Air Force and N.A.T.O. squadrons.* 257 *Squadron, R.A.F., Wattisham, were the second squadron to convert to Hunters last autumn. They are equipped with Mark* 2 *Hunter aircraft, which are armed with* 30-*mm. cannon and are capable of exceeding Mach* 1 *in a dive.*

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MINISTRY OF WEAPONS

The transfer to the Board of Trade of the Ministry of Supply's responsibilities for most of the metal and engineering industries marks the end of a long period of transition during which Government controls have slowly been diminished and the Ministry's concern with those industries has become virtually confined to trade matters and the collection of production statistics. According to the Prime Minister the main purpose of the change, planned some two years ago, is to free the Ministry from matters not directly concerned with "its prime task of supplying the armed forces."

For some time now the Ministry's function as a controller of scarce materials has been relatively minor, though in a rapidly expanding economy shortages are bound to occur—as at present in the case of sheet and certain special steels, low-phosphorus pig iron, and nickel. On the whole, however, rationing by price—as in the case of copper—has taken over and any Government assistance or advice industry might require can be given by the Board of Trade. The Ministry's only concern will be that strategic requirements should be met. A more vital function in recent years has been the sponsoring of research and development work; technical progress in a number of engineering industries would have been slower but for the encouragement and financial support provided by the Ministry's development contracts. The difficulty now is where to draw the line.

The Ministry's exclusive but intimate concern with the supply of military equipment will inevitably extend to the more important suppliers of the armament industries, such as special steels, light metals and electronics. The most important armaments for which the Ministry is responsible are aircraft, guided missiles and atomic weapons. So far it has borne the main financial burden for research and development—in less than ten years it has paid out nearly £300 million to the aircraft industry—and full responsibility for the direction of research. It will obviously be difficult to separate the research on civilian aircraft from that on military aircraft, and research on atomic weapons from that on atomic plant for industry. The shedding of the Ministry's responsibilities for metals and engineering should, however, enable it to concentrate more single-mindedly on the development and production of weapons vital to the security of the nation, and the by-products of this activity should continue to benefit industry at large and engineering in particular. In due course, there may be a further transfer of responsibilities from Government to industry and, in the process, some valuable economies in the cost of new weapons to the taxpayer.

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HIGH-VACUUM TECHNIQUE

The growth of high-vacuum technique since the war has been astonishing. In the 1930's the equipment was almost entirely imported, mainly from Germany and the United States. W. Edwards and Company (London), Limited, were then laboratory furnishers and importers, being agents for E. Leybold of Cologne. They began to manufacture during the war and are now the larger of two producers of a full range of equipment, the other being the Metropolitan-Vickers Electrical Company, Limited. Although other companies have begun to manufacture some items of high-vacuum plant, Edwards are firmly installed in this highly specialised industry, and in a good position to withstand competition from imports, though this may become intense now that Leybold have set up a sales company in this country.

The main applications of high-vacuum technique have so far been for coating plants ("evaporation" or "cathodic sputtering"), the production of cathode-ray tubes and radio valves, freeze drying and a large number of applications in the production of atomic energy. Edwards, who have now changed their name to Edwards High Vacuum, Limited (the better to reflect their production activities), consider that very large outlets for their plant exist in chemical engineering and vacuum metallurgy and have recently expanded their factory to meet the anticipated demand. This is one outstanding example where the war, by cutting off supplies from Germany, has led to the successful establishment in this country of a new industry. The test during the coming years will be the extent to which technical progress can be made to match the efforts of foreign competitors, a test similar to that being undergone by a wide range of other engineering industries.

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RESTRICTIVE PRACTICES

There has been a good deal of propaganda recently, tinged with varying political colours, about the need to curb the proclivity in certain industries to foster restrictive practices. In this connection, the Federation of British Industries has brought out a pamphlet called "Restrictive Business Practices and the Public Interest" which is intended as something of a counter-blast to indiscriminate propaganda against monopolies. The Federation's comments amount to this, that although it "favours a general system of competitive free enterprise" and supports the activities of the Monopolies Commission, it considers that there may be a case for studying each particular case of restrictive practice on its merits. The Federation is thus making a plea for a reasonable consideration of the other point of view—no more. The dangers of such an attitude are that its best intentions will be misunderstood. What is intended as no more than a mild case for the defence in public discussion becomes represented as the judge's summing up. Furthermore, in the desire to make the point that the exception may prove the rule, the basic principles may become rather blurred.

Fair-minded and tolerant as the Federation's attitude may be on this issue, it is important that the principles should be established and the exceptions allowed afterwards. The difficulty of keeping the issues clear if one tries to argue the other way round is that existing cases of restriction are not called upon to prove that they are exceptions to a principle, but only required to offer plausible excuses why they should continue. The Federation lists a number of examples where restrictive practices may be acceptable, but the fact remains that restriction is exceedingly difficult to justify in a changing, progressive world where competition is forced on an industry, as for example in export markets. An industry which is protected by price agreements, etc., finds it difficult to compete efficiently for new capital, labour and markets if those restrictions are allowed to give protection indefinitely.

It is by no means certain that the enforcement of the basic principles of competition in a free market would harm manufacturers as much as they imagine, provided that the war against monopolies was waged against buyers as well as sellers. The virtues of competition apply to both sides of the market and no industry is more aware than the engineering industry of the bargaining advantage which State trading organisations and public corporations enjoy because there are no other buyers in competition.

PEACE IN INDUSTRY

The real need of the present time in the industrial field, Sir Walter Monckton, the Minister of Labour, told the House of Commons in last week's debate on labour unrest, was for an upsurge of a feeling of responsibility towards the nation as a whole. The idea should be more generally entertained, he suggested, that people worked not for themselves alone, but for the good of the country and of all who lived in it. He made it abundantly clear that this feeling of responsibility towards others was not a matter which could be developed by legislation.

Britain's industrial relations would never really prosper, he said, until they were based on sound human relations. The main object of everyone should be to create confidence between managements and workpeople; such a confidence as would allow men to work together with understanding and a common approach towards the problems of industry. It should be realised that a man brought more to his factory and his work than the mere labour of his hands. He brought a part of his life and he should be able to enjoy rights and satisfactions in his working life, just as he did in his life at home.

The recognition of the human factor was of outstanding importance in labour relations and the policy of managements should be based on a recognition of the fact that a man was not a tool or a machine, but a complex human personality. An adequate appreciation of this position should be the aim of managements in their human relations, and they should develop the same outlook among their employees. That was the way in which leadership could be given and people generally made conscious of it. Such a policy was indeed accepted and operated over a wide field, but, Sir Walter said, it should be made the universal aim throughout the whole of British industry. That demanded full co-operation from organised labour as well as goodwill and leadership from managements.

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ITALIAN CASE STUDY

Ten-year development plans are very fashionable these days. The scheme prepared by the Italian Government which was recently submitted to a working party of the Organisation for European Economic Co-operation is a particularly interesting example. Basically, the Italian Government is faced in Southern Italy with the same problems as any other country with an underdeveloped region. The fact, however, that Italy is highly industrialised in the north, and a country of Western Europe with a unique cultural heritage makes the ten-year plan for economic development worth watching. The environment in which the plan will operate is likely to provide a high-speed case study, for better or for worse, of development in backward regions.

In essence, the plan for Southern Italy is to eliminate persistent unemployment, to improve the economic balance between north and south and to eliminate the balance-of-payment deficit on current account. The plan proposes to achieve these objects by large-scale capital investment in industry and agriculture, with special reference to power, water and transport. This large-scale investment is to be followed up with a flexibly planned programme of housing and forestry. In terms of employment, the scheme has to create jobs for 1,350,000 persons, after allowance has been made for immigration from Southern Italy to the north and abroad.

In their comments on the plan, the O.E.E.C. experts consider that three kinds of problems may emerge: first, there is the possibility that the capital investment may not be on a large enough scale to mop up the number of unemployed, including the natural increase in the population; second, that inflationary pressure may develop which may call for deflationary measures from the Italian Government, thus cramping the later stages of the plan which will require a major effort from private enterprise; third, that as incomes increase there may be too big an

increase in imports. The plan therefore calls for a nice calculation of the correct speed of development.

Italy is likely to provide a useful object lesson in how to phase the demand for industrial and agricultural equipment after the initial planning and estimating have been completed. One consequence for this country will be that the Italian engineering industry will be under great official pressure to increase its exports while Italy's import bill is made to fluctuate to meet the requirements of orderly progress with the ten-year plan. If the plan succeeds, Italian industry will be known in the markets of the world ten years from now, not only for the quality of its workmanship but also for its quantity.

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WINNING COAL

In 1954 the demand for fuel and power in the United Kingdom continued to grow, but the coal industry could meet only part of the increase and the gap had to be filled mainly by imports. Nevertheless, the latest annual report of the National Coal Board (available from H.M. Stationery Office, price 7*s.* 6*d.*) is an optimistic document which shows that the management is well prepared to enter the new atomic age playing the part that must be required of it for many years to come. Almost half the pits were free from disputes during the year, there was a welcome improvement in recruitment and the wastage figure was slightly lower than previously; in particular, the annual net gain in boys employed under the age of 18 has increased by over 50 per cent. from just under 10,000 in 1948 to over 15,000 last year. In the same period N.C.B. training scholarships have enabled 205 men to graduate and, furthermore, during last year, 256 recruits were obtained from universities and colleges to undergo "direct practical training" in which they are systematically introduced to good management.

The establishment of a comprehensive scientific service was begun with nationalisation. During 1954, scientific control was the responsibility of three groups and research was divided among many agencies, some within, some outside, the Board's direct control. The report is emphatic, however, in insisting that no division exists between scientific control and research, and that together they are planned as a whole.

Recently, and since the end of the period reviewed in the report, work study has been introduced into the industry. Time and motion study is now being applied to surface work in two areas, South Yorkshire and the East Midlands. Sending stop watches—and watchers—into the coalfields is a bold step and final success will require determined efforts of tact and patience. The real test will come when the watches go to the working face. There, the independence of the miner is at its strongest and the influence of the management, as yet, at its weakest. The most valuable results are not necessarily to be gained below ground however. There is much to be achieved on the surface, and systematic time and motion study—followed by other techniques of good management—may become accepted if outputs are increased and the men can share in the reward. Remembering also the rapid implementation at top level of the Fleck report there are encouraging signs of an enlightened management at work.

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EUROPEAN NUCLEAR ENERGY

A recent report of the Organisation for European Economic Co-operation, *Certain Aspects of the Use of Energy in O.E.E.C. Member Countries. Suggestions for Direct or Indirect Collective Action*, contains some useful analysis of consumption and production of power in the various European countries and its relationship to productivity and national income. It points out that higher income per head in the United States is attributable not only to the abundance of power but also to its cheapness. An expansion of power will not in itself improve the situation in other countries if costs remain high in relation to labour, and the lowering of costs becomes more imperative where labour is cheapest. The advent of atomic energy is thus of great importance to countries which are under-developed through lack of power supplies. The cost of atomic power is not, as yet, competitive with that of other forms of energy where suitable resources exist, but in regions lacking coalfields, large hydro-electric schemes, etc., it will be competitive from the start. Moreover, the present cost of 0·6*d.* per kilowatt-hour, as given in the British White Paper, *A Programme of Nuclear Power* of February, 1955, although not lower than that of up-to-date thermal stations, is below the average cost for thermal generation in the United Kingdom. While it is likely to stay at present levels for the next two years, it should diminish thereafter as technique improves. The Cowles Commission for Research in Economics have predicted 0·4*d.* or even 0·35*d.* per kilowatt-hour.

How effectively and quickly costs can be brought down will depend upon the co-operation which can be secured among the various European countries. Given the maximum co-ordinated effort, backed by the mobilised industrial potential of all the members, European nuclear-energy prospects would be as favourable as those of the United States—but only under such conditions. The report claims that the necessity for association has been grasped in the United States where "despite the competitive spirit which so happily prevails between a number of industrial groups sufficiently powerful to act in isolation" a movement has been started for pooling the financial and technical resources of 33 companies. The grouping of British companies which has already taken place does not seem to meet the case, for the writers of the report think that a similar pooling of resources in Europe would call for international action. It may perhaps be agreed that a European co-operative solution would be preferable to a strictly national one, and the establishment of three bodies, the European Organisation for Nuclear Research, the European Society for Atomic Energy and the International Agency for Atomic energy is at least a useful beginning. They will facilitate the exchange of scientific knowledge and the supply of fissile material, although not the exchange of technical information nor the joint construction and financing of plant.

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BRITISH POWER CO-OPERATION

As is argued in another note, international co-operation may be necessary to obtain the fullest advantages from nuclear power. Much can be achieved, however, by co-operative effort on a purely national level and in recent months some publicity (in these Notes as well as elsewhere) has been given to the industrial groupings which are being formed for the purpose by British plant manufacturers. Two companies which are participating in such groups, Head Wrightson and Company, Limited, and John Thompson, Limited, have recently published their annual reports and the statements of the chairmen contain some reference to their activity in this direction. Head Wrightson are members of the consortium under the leadership of Sir Claude Gibb, chairman of C. A. Parsons and Company, Limited, and of A. Reyrolle and Company, which is to undertake production of complete nuclear power plants. Their subsidiary, Head Wrightson Processes, Limited, are already working on contracts for three reactors in the United Kingdom, and are negotiating with the Australian Government in the matter of the first reactor to be built in Australia. They have also obtained the contract for the design and erection of the heavy-water plant which will form part of the scheme for using steam from the geothermal springs in New Zealand.

The John Thompson Group have obtained the major engineering contract for Dounreay, the first full-scale British "fast-breeder" reactor for power production. As a separate project, they have associated themselves with the Associated Electrical Industries Group with whom they are forming a study group which is working to place itself in a position to build complete atomic stations of the gas-cooled reactor type. The study group, who have been undergoing intensive courses under the auspices of the United Kingdom Atomic Energy Authority, are established in their own design offices near Manchester where they are already engaged on problems of reactor engineering and heat-exchanger design. The effect of recent atomic developments on demand for the more traditional John Thompson products should be fairly limited, however, for the next 20 years. By 1975 only one-fifth of British generating capacity is likely to be coming from nuclear sources, and the remainder will still be provided by conventional steam-raising plant. There can be no question of slackening off the work of evolving more efficient designs for coal and oil-fired boiler plant—particularly to make more effective use of the low-grade coals which will form an increasing proportion of the fuel supplies to power stations.

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JET ENGINES FOR THE WORLD

The Hawker Siddeley Group point out in a recent statement that licences for the manufacture of British jet engines sold to the United States have brought in millions of dollars and that over 5,000 Armstrong Siddeley Sapphires alone have been made in the U.S. The arrival in London last week of senior executives of the Douglas Aircraft company gives rise to the possibility that yet another British engine, the Rolls-Royce Conway, will find a market in the U.S. Douglas are considering the Conway, the first large turbo-jet employing the by-pass system, for their D.C.8 air-liner which is designed to carry 80 to 125 passengers non-stop between the U.S. and Europe at a maximum speed of over 550 m.p.h. The engine originally proposed for this aircraft was the Pratt and Whitney J57. American designed jet-engines are, however, beginning to be used for commercial aircraft: the Allison 501, the first American turbo-prop to be certificated for commercial operations, is to be used on the Lockheed Electra, a 65-seat competitor of the Vickers Viscount. One American domestic airline has already ordered 35 (delivery to begin in 1958), and others may follow their example.

Hitherto, the main emphasis in jet-engine development has been on the evolution of ever more powerful and complex units. As Hawker Siddeley point out, however, there are great export opportunities for lightweight engines for light economical fighters, trainers and small speedy communication planes. The application of recent knowledge and technique has already produced a lightweight engine for the Folland Gnat which combines high thrust with comparable efficiency, but there is more scope for an even smaller simplified engine. The Armstrong Siddeley Viper is being developed for this rôle. Originally designed as a short-life engine to give high manoeuvrability to the Jindvik guided missile, it combined reasonably high efficiency with low cost. Its possibilities as a long-life engine were soon evident, however, and the conversion of the "short-life" version to normal standards proved to be quite straightforward. The Hunting Percival Jet Provost powered by the Viper is now undergoing evaluation by the R.A.F. and will probably be in service before the end of the year. Long-life Vipers have accumulated 500 flying-hours in a variety of rôles including, besides the Jet Provost, the Folland Midge and the French Trident, which with two Vipers and a rocket motor has broken the sound barrier on the climb. Armstrong Siddeley are being given every encouragement to develop the Viper further and to produce it in quantity parallel with their super-priority, purely military projects like the Sapphire. This should enable costs to be reduced and open up extensive new markets for jet engines.

MECHANICAL ENGINEERING RESEARCH

D.S.I.R. REPORT FOR 1954

The work carried out in the Mechanical Engineering Research Laboratory at East Kilbride, Glasgow, during 1954 is reviewed in the Report of the Mechanical Engineering Research Board and described in detail in the Report of the Director of Mechanical Engineering Research; these two reports have now been published* in a single volume.

The Hydraulic Machinery building of the Laboratory at East Kilbride, Glasgow, was occupied at the end of the year and work started on the Heat Transfer building and the Mechanisms and Metrology building. Under the five-year plan of the Department a Plasticity laboratory and an Administration building will also be constructed. The non-industrial staff of the Laboratory increased by over 25 per cent. during the year and reached a total of 226. A shortage of industrial staff in the workshop is described as being a cause of delay in meeting demands for special apparatus and test pieces. The five-year plan provides for the further employment of 140 non-industrial staff by March 31, 1959, but no corresponding figure is as yet available for industrial staff.

The work of the Laboratory is handled by six divisions: Heat, Mechanics and Materials, Mechanisms and Metrology, Fluids, Lubrication, and Plasticity. Details of the research undertaken in each of these divisions during the year under review are given fully in the Director's report, but some extracts are given below.

IMPROVEMENT OF INDUSTRIAL CONDENSERS

Methods of promoting dropwise condensation in steam condensers have been investigated at the request of the Laboratory at Queen Mary College, University of London. The importance of dropwise condensation lies in the increased efficiency of the condenser when the steam can be made to condense in drops, rather than as a film on the condensing surface. If continuous dropwise condensation could be maintained in commercial condensing plant the capacity of existing plant could be increased, and the capital cost of new plant could be considerably reduced because smaller condensers would be required. A report of this work was published in ENGINEERING, for April 15, last (page 464 *ante*).

Work also carried out under an extra-departmental contract at Queen Mary College has resulted in the synthesis of about a hundred substances which promote dropwise condensation and which form chemical bonds with brass or copper, the materials usually used for condensing surfaces. Following laboratory tests, in which certain of the compounds functioned satisfactorily for as long as five months, tests under working conditions are now being carried out on the condenser tubes of a small cross-channel steamer and in a power station.

PROPAGATION OF FATIGUE CRACKS

Little has been known until recently about the way fatigue cracks form and grow. It is usually assumed that once a crack has formed it will spread rapidly due to the high stress concentration set up at the tip of the crack. Work at the Laboratory has shown that cracks in V-notched specimens of an aluminium alloy formed at low applied stresses grow to their maximum depth in 100,000 cycles; no further growth of the cracks occurs with repeated loading up to 30 million cycles. Investigation of the length of crack formed under different nominal stresses suggests that the maximum length of non-propagating crack can be predicted from the stress distribution near the notch. It seems that for each material there is a limiting maximum stress concentration factor which is determined by the ratio of the stress needed to start fatigue cracks to that required to make them grow.

The complex-stress, high-temperature creep laboratory is now in full use and the behaviour of power-plant steels under cyclic conditions of stress and temperature is being studied. In particular, the effects of cycles of plastic strain on gas-turbine rims at their normal working temperatures have been examined.

Until recently, creep under complex-stress systems at high temperatures has been measured under steady-stress conditions. In a number of practical cases, however, the stress varies and a particular instance of this is relaxation where stress falls with time, while the total strain remains constant. Examples of components in which creep takes place under relaxation conditions are high-temperature pipe flanges and cooled discs in aircraft gas-turbines. A combined tension and torsion machine has been constructed to provide the basic data for the design of this type of component, and relaxation tests under combined stresses are being carried out on a range of engineering materials, including a 0·17 per cent. carbon steel, a Nimonic alloy, aluminium alloy RR59, a 98 per cent. pure magnesium alloy, and a commercially pure copper.

PNEUMATIC GAUGING

At the request of a firm of razor-blade manufacturers the Laboratory has developed a simple instrument which measures the width of double-edged razor blades and checks whether the slots are central between the edges. The firm had previously used a dial indicator for the purpose but this damaged the edges of several thousand blades daily. The inexpensive pneumatic gauge produced by the Laboratory makes the measurements without touching the edge of the blade. It consists of two measuring heads connected to a pneumatic system. Each head has two orifices one above the other. Air at constant pressure is supplied to the lower orifice, the air stream passing from the orifice across an air gap to the upper orifice, which is connected to a bellows-type pressure gauge. The blade obstructs the air flow across the gap and alters the pressure reading. As the reading is dependent on the degree of obstruction the two half-widths are indicated directly on two gauges. To provide a continuous check on blade width during production, without removing blades for gauging, a similar instrument which fits on to the grinding machine has been produced and is now under test.

HYDRAULIC SYSTEMS AND LUBRICATION

The performance of oil hydraulic systems is now being investigated in the Laboratory. Existing design data are inadequate for the higher speeds and working pressures now required; particular attention is being paid to basic components such as pumps and valves. The study of the operation of a spool-type piston-valve has shown that the axial force on the valve is not constant for different positions of the piston. Near closure, the force rises rapidly and this has been found to be associated with sudden change in the direction of oil flow through the ports. The speed of positive displacement pumps is often limited by the performance of the self-acting valve. Preliminary work on this type of valve has indicated that cavitation takes place in the entry to the suction valve before it occurs in the valve itself, emphasising the importance of good entry design.

Work is being continued into the study of lubrication and wear, use being made of radio-active isotopes for examining the process of wear. A method of visual examination of lubricant behaviour is being used to study the extent to which an oil film develops in journal bearings. Transparent bearings of Perspex or glass are used and the oil film is made to fluoresce by irradiation with ultra-violet light. It has been found that the inlet film is incomplete even with high inlet pressures; this is contrary to the usual assumption in theoretical analyses that the inlet film is complete. The technique of using transparent bearings has opened up a wide field for studying oil flow through journal and thrust bearings.

To study the effect of variations of temperature at different points in bearings, a method of recording continuously the temperature of different parts of a bearing under working conditions has been devised. In a bush of 2-inch bore, 100 thermocouples are inserted in a radial and circumferential array of holes. The method will be used to provide data from which to calculate frictional losses.

* *Mechanical Engineering Research*, 1954. Published for the Department of Scientific and Industrial Research by H. M. Stationery Office, Kingsway, London, W.C.2. (3*s*. or 54 cents in U.S.A.)

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A CAREER IN ELECTRICAL ENGINEERING

Film for Schoolboys

Speaking at a preview of a film made to attract young men to the electrical-engineering industry, Mr. J. Eccles, C.B.E., M.I.E.E., M.I.C.E., M.I.Mech.E., President of the Institution of Electrical Engineers and vice-Chairman of the Central Electricity Authority, referred to the present crisis in the demand for technologically trained personnel. In such fields as nuclear and railway engineering, the design of computing machines, radar, and radio technology the need for skilled imaginative minds would increasingly be felt; and if the country was to survive it was necessary to influence boys in public and secondary grammar schools to think in terms of technology when choosing their careers.

To catch the imagination of schoolboys with these qualities, a film entitled "The Inquiring Mind" has been produced for the Institution of Electrical Engineers and has been sponsored by the Institution in collaboration with trade associations, electrical-engineering firms and various other organisations. The purpose of the film is to depict the diverse fields of opportunity open to electrical engineers and to reveal the wide horizons which new applications of electricity present. A career in electrical engineering is shown to offer scope for great personal satisfaction both from technical achievement and through service to the community by providing improved living standards and an increased national prosperity.

The film opens with a survey of the great scientific principles and discoveries on which electrical technology is based and proceeds to show their applications in the modern world, using dramatic shots of electrical installations both under construction and in service. The picture is linked by glances at the progress of a schoolboy whose interest in science leads him from a classical education to a career in electrical engineering. Camera movement and rapid cutting give the film a sense of excitement and ensure that interest is held throughout. It is in fact a film that whets the appetite, and is capable of inspiring a sceptical adult, let alone an impressionable schoolboy.

"The Inquiring Mind" has been produced by Variety Films Limited, of the Film Producers' Guild, Upper St. Martin's-lane, London, W.C.2, and has been directed by Mr. Seafield Head. It runs for 30 minutes and is made in 16-mm. and 35-mm. versions, with sound. Particulars regarding the loan of the film and booklets dealing with careers in electrical engineering may be obtained from the secretary of the Institution of Electrical Engineers, Savoy-place, London, W.C.2.

Letters to the Editor

DRAWING AND DESIGN

SIR, We must all be grateful to Mr. Clausen for his admirable article on Drawing and Design in last week's ENGINEERING, so timely at a period when the subject seems to be receiving less attention than in the past in our Colleges and Universities. It is perhaps worth remarking that the mental disciplines involved in the dimensioning of components for interchangeable manufacture are severe; and that these modern techniques require of the person concerned with them at the design stage those qualities of vision and intelligence usually associated with professional engineers.

Yours faithfully,
W. ABBOTT.

Director of Studies,
Federation of British Industries,
Westminster.
June 24, 1955.

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OIL FILM EXTENT IN COMPLETE JOURNAL BEARINGS

SIR, The article on oil films in your issue of April 29, together with the beautiful pictures, have been of great interest to us.

One of the difficulties occasionally encountered in high-speed heavily-loaded bearings associated with gears such as the pinion bearings for planetary reduction gear sets is cavitation erosion of the bearing material. We have not done any work with transparent bearings although we have done a good deal of test running in connection with this condition. I must say that we have never arrived at a generalised solution of the difficulty. Looking at the illustrations in the article, particularly Fig. 5, suggests that possibily the relieved bushing together with adequate inlet oil pressure might give a solution to this cavitation trouble. Has this possibility been considered? I assume that the glass bearing has not been run under the severe conditions which would probably be necessary to produce erosion.

Sincerely yours,
E. A. RYDER,
Consulting Engineer.

Pratt & Whitney Aircraft,
East Hartford, 8,
Connecticut, U.S.A.
June 6, 1955.

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HIGHER NATIONAL CERTIFICATE IN CHEMICAL ENGINEERING

SIR, Dr. E. H. T. Hoblyn, Director of the British Chemical Plant Manufacturers Association, in a letter published in your issue of June 10, has drawn attention to a statement in the Annual Report of the B.C.P.M.A. relating to Higher National Certificate Courses in Chemical Engineering to which reference was made in Weekly Survey of May 27. A summary of the present state of development of these courses may be opportune.

The establishment of courses in a new, or comparatively new, primary technology like chemical engineering is necessarily a slow business. It is also a long-term investment of national importance.

The scheme for the award of these certificates was agreed with the Ministry of Education in 1951, and with the Scottish Education Department in 1953. To-day, courses are in operation at the following colleges: Acton Technical College, London (1st and 2nd year courses only); Battersea Polytechnic, London; Birkenhead Technical College; Heriot-Watt College, Edinburgh; Huddersfield Technical College; Neath Technical College; Hull Technical College; Northampton Polytechnic, London (1st and 2nd year courses only); Royal Technical College, Glasgow; and West Ham College of Technology.

The quality of the young men who have already qualified is high, and their services are in demand in industry. The numbers so far enrolled are small. A greatly increased co-operation between local education authorities and local industries is required to give the country the chemical engineers it needs.

We believe that this co-operation will be forthcoming.

Yours faithfully,
M. B. DONALD,
F. E. WARNER,
Joint Honorary Secretaries.

The Institution of Chemical Engineers,
56 Victoria-street,
Westminster,
London, S.W.1.
June 22, 1955.

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SAFETY OF OIL-FIRED BOILER INSTALLATIONS

SIR, As the safety of oil-fired boiler installations is a matter with which I am particularly concerned, I was very interested to read Mr. Whillock's article on this subject on page 730 of ENGINEERING of June 10. The standard he advocates is generally that required in premises under the control of the London County Council; indeed, some portions are almost word-for-word quotations of a directive issued for the guidance of the Council's technical officers.

The most frequent type of accident experienced with automatic oil-fired boilers arises from accidental ignition of a large volume of explosive mixture in the combustion chamber, either during the initial starting operation or during restarting after a flame failure. This is best guarded against by an efficient ignition system (e.g., a gas pilot flame) and by fitting one of the various oil cut-off devices now available which are almost instantaneous in action. Flue resistance should be kept to an absolute minimum so as to ensure rapid clearance of any unburnt gases to the outside air, and obviously an adequate air supply to the boiler is also important in this connection, particularly in those cases where provision is made for one or more automatic repetitions of the starting cycle; and obviously ample time must be allowed for the discharge of unburnt gases. Proper provision for explosion relief is another important consideration.

The danger of uncontrolled leakage of oil into the boiler chamber would appear to be safeguarded by the float-switch cut-off device mentioned by the author; this was recently originated by myself and my colleagues as a possible alternative to the provision of a daily service tank, but, so far as I am aware, has not yet been given a practical test.

I do not think Mr. Whillock's other suggestion, viz.: "a cut-off device inserted in the oil-feed pipe within the storage chamber and connected electrically with the burners, and so designed that in the event of the burners going out due either to the normal conditions of operation or to the cessation of the oil supply owing to a leak, the device would shut off the oil supply immediately," would be very satisfactory, as oil leakage from a feed pipe or service tank could occur without resulting in flame failure. Moreover, automatic oil burners normally start up and shut down at more or less frequent intervals during operation and the suggested arrangement would be unworkable where two or more boilers are concerned.

Another type of accident which occurs from time to time involves damage to the storage tank or fittings due to inadvertent overfilling. B.S. 799 : 1953 includes graphs showing the pressure to which a tank may be subjected due to the static head of oil in the vent pipe, but this figure is actually of little consequence. What is important is the pressure on the tank when, due to overfilling, the free oil surface area is suddenly reduced from the area of the top of the tank to the cross-sectional area of the vent pipe. The hammer-blow effect at this instant, particularly in the case of rectangular or other flat-topped tanks, is very considerable, and may approximate to the tank wagon delivery pressure. This point does not appear to have been considered by the B.S.I. Committee in preparing B.S. 799, but I have since drawn their attention to it. The danger can be largely overcome by arranging that the vent pipe projects several inches below the top of the tank, so providing an air cushion above the oil which will absorb the shock due to the sudden reduction in the free surface area of the oil.

Yours faithfully,
L. C. ROBERTS.

100 Green-lane,
Thornton Heath,
Surrey.
June 23, 1955.

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INTERNATIONAL FOUNDRY CONGRESS BANQUET

Apart from an all-day excursion to Oxford on Saturday, June 25, the closing London function of the recent International Foundry Congress was the banquet held at the Dorchester Hotel, Park-lane, on the evening of June 24. The congress, which was the 22nd of the series, also constituted the 52nd annual conference of the Institute of British Foundrymen, the organisers of the meeting, under the auspices of the International Committee of Foundry Technical Associations.

At the banquet, Lord Kilmuir, G.C.V.O., Lord High Chancellor, proposed the toast of the foundry industry. He stated that during its 51 years of existence the Institute's work had had great influence in accelerating the advances made in foundry technique. Two keynotes of these advances had been courage and understanding. To introduce new methods and to see them through to the production stage needed courage, and every improvement introduced in foundries demanded a high degree of understanding between managements and workpeople. He congratulated the industry on the recent announcement that for the first time on record the ironfoundries of the United Kingdom had produced more than a million tons of iron castings in a quarter (the actual output for the first quarter of 1955 was 1,018,000 tons). The industry, said Lord Kilmuir in conclusion, should not, however, rest on its laurels but continue to increase its output still further.

In reply to the toast, the President, Dr. A. B. Everest, said that the past 50 years had witnessed much progress, including the birth and growth of the great light-alloy castings industry. Furthermore, during the past 30 years there had been a threefold increase in the strength of cast iron.

The toast of the Lord Mayor, the Sheriffs and the Corporation of London was proposed by Mr. H. J. V. Williams, senior vice-president of the Institute, and, in the course of his reply, the Lord Mayor, Alderman Sir H. W. Seymour Howard, recalled that the Worshipful Company of Founders had applied for its ordinances in 1365, in the time of Chaucer, when Anglo-Saxon and Norman words were being blended and the English language was being formed.

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TELEVISION TRAINING CENTRE

A television training centre has been established by the Broadcasting Division of Marconi's Wireless Telegraph Company, Limited, at St. Mary Abbot's-place, London, W.8. It will provide a complete course in the operation and maintenance of television studio equipment and will be available to any organisation for training their studio and production staffs. Telecine equipment has been installed for those wishing to appraise filmed programmes on television and there is a complete mobile outside broadcasting unit with which experience can be obtained in the production of recorded programmes. Arrangements can also be made for live broadcasts to be undertaken.

ANGLO-AMERICAN CONFERENCE ON AERONAUTICS

A REPORT FROM LOS ANGELES

During the past fortnight some 140 representatives of the British aircraft industry and many more of their counterparts in the United States have been in Los Angeles attending the Anglo-American Aeronautical Conference which ends to-day (July 1). Organised jointly by the Institute of Aeronautical Sciences of the United States and the Royal Aeronautical Society, and held in alternate years, the first conference took place in London in 1947. The present gathering is the fifth of the series and the second to be held in America.

In opening the conference, Mr. Robert E. Gross, President of the Institute of Aeronautical Sciences, said that the key to the solution of the problem of the technical manpower shortage lay, not in trying to train and produce a greater number of engineers, but in learning to make better use of the present engineering population. These conferences, he thought, were a contribution to that end. Both Mr. Gross and Mr. N. E. Rowe, President of the Royal Aeronautical Society, expressed the hope that the conference would help in promoting peace throughout the world.

The first three days of the conference—June 20 to 22—were devoted to concentrated technical sessions. Subsequently there have been visits to some of the principal aeronautical firms of the United States, a large proportion of which are located in California, including the Lockheed, Douglas, North American, Aerojet-General, Marquardt, and Northup companies. Visits were also made by some delegates to the Chevrolet assembly plant, Zenith Plastics Company, and the aluminium division of the Harvey Machine Tool Company, to the California Institute of Technology wind tunnel and jet-propulsion laboratory at Pasadena, and to United States Air Force flight test centres.

The following papers were presented at the technical sessions: "Operation of Turbo-prop Aircraft," by Mr. P. G. Masefield, British European Airways; "Air-Line Use of Elementary Statistical Methods in Aircraft Performance Measurement," by Mr. W. C. Mentzer and Mr. F. S. Nolan, United Air Liners Incorporated; "Design of High-Speed Aircraft," by Mr. Edward H. Heinemann, El Segundo division of the Douglas Aircraft Company, Incorporated; "Design of Large Helicopters," by Mr. Bartram Kelley, Texas division of the Bell Aircraft Corporation; "Stress Analysis of Multiweb Boxes," by Professor W. S. Hemp, College of Aeronautics, Cranfield; "The Interaction between Shock Waves and Boundary Layers," by Mr. D. W. Holden, National Physical Laboratory; "Contributions to Fluid Mechanics from Shock Tube Research," by Mr. G. N. Patterson, director, and Mr. I. I. Glass, Institute of Aerophysics, University of Toronto; "Hypersonic Flow," by Professor Lester Lees, California Institute of Technology; "On the Behaviour of Boundary Layers at Supersonic Speeds," by Mr. R. J. Monaghan, Royal Aircraft Establishment; "Some Results of the Princeton University Smoke Flow Visualisation Programme," by Professor David C. Heron, Princeton University; "Fatigue of Pressure Cabins," by Mr. P. B. Walker, Royal Aircraft Establishment; "Some Influences of Equipment Installations and Systems on Aircraft Design," by Mr. Charles F. Joy, Handley Page, Limited; "Power Control Systems for Aircraft," by Mr. John W. Ludwig, Chance Vought Aircraft Incorporated; "Jet Noise," by Mr. F. B. Greatrex, Rolls-Royce, Limited; "Combustion for Aircraft Engines," by Mr. Walter T. Olson, National Advisory Committee for Aeronautics; "Low Consumption Turbine Engines," by Mr. Adrian A. Lombard, Rolls-Royce, Limited, and "Power Plants for Supersonic Flight," by Dr. Eric Stanley Moult, de Havilland Engine Company, Limited.

Some of these papers were intended for consumption by specialists working in the same field, while other papers presented broad surveys of their subject. We propose to summarise only those papers which have a more general engineering interest.

TURBO-PROPELLER AIRCRAFT

In the first of the technical sessions, Mr. Peter Masefield, chief executive of British European Airways, expressed the view that the turbo-propeller-powered aircraft of the next generation would be more economical over all stage distances from 200 to 4,000 miles than either the piston-engine or the turbojet transport aeroplane. The propeller turbine combined a comparatively high speed with low costs and engineering simplicity. It was more economical and flexible in service than the jet; and smoother in operation and requiring substantially less maintenance than the piston engine. He thought, however, that the higher speeds of the jet air liner would still be attractive on certain routes.

In his paper, Mr. Masefield summarised B.E.A.'s operating results with the Viscount; surveyed the history of the Viscount and its Dart engines; discussed some of the operational characteristics of turbo-propeller aircraft, and techniques developed by B.E.A.; presented a summary of Viscount economics; and analysed future prospects, with special reference to the promise of the Britannia air liner.

The B.E.A. Viscount fleet had, in 25½ months of commercial operation, flown 11½ million aircraft miles. Their longest sector distance was 1,086 miles (London to Gibraltar) and their shortest 65 miles (Manchester to Birmingham). Over all these routes the Viscount had improved B.E.A.'s competitive position. With full air-line fuel reserves, the Viscount 701A carried its maximum payload, 11,808 lb., over 950 statute miles, and a payload of 9,858 lb. over the maximum sector distance with full fuel tanks, 1,230 statute miles. Engine and propeller maintenance and overhaul costs amounted to 13 per cent. of the total, and this figure had recently been substantially reduced.

The Dart had advanced from 1,125 e.h.p. in 1947 to 1,780 e.h.p. in June, 1955, and 2,268 e.h.p. in the engines to be delivered in December, 1956. Although conceived in 1945, and inferior to to-day's designs, the Dart had the advantage of a background wealth of airline operating experience. Its reliability was encouraging—it had proved to be less temperamental than some of its piston cousins. B.E.A.'s Darts were now running at 1,050 hours between overhauls, with flame tube changes at 750 hours and about to be increased to 1,050 hours. The immediate target was at least 1,250 hours for the complete engine, with a longer-term target of 2,000 hours for the cold part.

Discussing operational characteristics, Mr. Masefield said that at present the hourly fuel consumption was about double that of equivalent piston-engined aircraft, and varied widely with operating height. For maximum fuel economy, the aircraft must be flown reasonably high. When there were air traffic-control restrictions on the climb, B.E.A. allowed for extra fuel—6 gallons for each 10 nautical miles of expected low-level cruise. For holding in the stack at low altitude before landing, however, the penalty was not great; if power and speed were reduced, the fuel consumption at 5,000 ft. was only about 7 per cent. more than that at corresponding conditions at 20,000 ft. The performance of a turbine engine suffered noticeably in hot weather, but at hot aerodromes take-off power could be restored by water/methanol injection.

Analyses of Viscount economics showed that over the most economic sector distance, 1,230 miles, each Viscount 701A could earn a profit of 700,000 dols. per annum at a 65 per cent. passenger load factor, which he believed compared favourably with any other equivalent transport aeroplane. Moreover, the total cost to B.E.A. of operating a Viscount, including overheads and interest on capital, was almost constant at 775,000 dols. per annum irrespective of sector distance. The 65-seat Viscount Major V.802, to be powered by more powerful Dart 510 engines, would improve the economic position still further when it came into service late in 1956.

Discussing the future, Mr. Masefield said that the more advanced types of propeller turbine now becoming available would make possible speeds up to 480 m.p.h. and capacities up to 130 seats or sector distances up to 5,000 miles.

Other papers will be reported in later issues of ENGINEERING.

BRITISH ELECTRICAL POWER CONVENTION

THE FUTURE OUTLOOK AND ITS PROBLEMS

The seventh British Electrical Power Convention was opened at Brighton on Monday, June 27, and closes to-day, Friday, (July 1), the President being Sir Harry Railing. The 38 organisations, which form its constituent membership, were all represented; and the attendance numbered over 2,000, thus imposing some stress on the accommodation of a famous watering place. As a matter of historical interest it may be mentioned that the first Municipal Electrical Convention, of which the present gathering is a descendant, was also held in Brighton in 1896, the president being Mr. Arthur Wright.

The theme of the Convention this year was Electricity and the Future, a subject which was covered in eight papers dealing with generation, the electrical industry as a career, and the use of electricity in the steel, coal, chemical and catering industries. A good deal of ground was covered in a short time and social events occupied a more secondary place than has sometimes been customary.

As on previous occasions, a feature of the Convention was an exhibition of technical and domestic appliances. This exhibition, which was organised by the British Electrical Development Association, was held in the Sports Stadium, some 23,000 sq. ft. of space being occupied by about 100 firms. It was opened by the President on Monday evening and was well attended both by delegates and the general public during the week.

PRESIDENTIAL ADDRESS

The first formal meeting was held in The Dome on Tuesday, June 28, when a civic welcome was accorded to those attending by the Mayor of Brighton (Alderman J. A. Trevelyan Leak, J.P.).

The President then delivered his address in which, after referring to the expansion which had taken place in the manufacturing and supply branches of the electrical industry during the past 20 years, he went on to say that its future hinged on the demand for energy. He would

therefore dwell not only on the demands of the next decade, but would touch on the problems of a longer period, discussing what resources were available to meet these demands and what long-term preparation was necessary now, or should be contemplated later.

It might be assumed that during the next decade there would be a slight increase in the population of the United Kingdom, that the demand for amenities and new materials would become more exigent and that the optimum amount of energy must be made available for each worker. The world demand for electricity was increasing at an average rate of 7 per cent. per annum. This increase might be expected to be even greater in the United Kingdom in the future, owing to an increase in the production of heavy engineering and capital goods as well as raw materials; to the enlarged demand for power, for transport and materials handling; and to the expansion of rural electricity. The relative backwardness of the domestic load would be remedied by the greater necessity to use labour-saving devices and the determination to eliminate the smog nuisance. The growing employment of electronic devices would also serve to increase electricity consumption.

POWER AND PROSPERITY

The Chancellor of the Exchequer had recently emphasised our opportunity to double our standard of living within 25 years, and Sir Harold Hartley had forecast that this doubling would take place in 40 years. For the Chancellor's programme, the present yearly coal use equivalent of 225 million tons would have to be increased to 460 million tons. For Sir Harold Hartley's forecast the figure would be 350 million. By making a forecast from past trends the conclusion was inescapable that electricity consumption would be 223,000 million kilowatt-hours in 1975 and the installed capacity 57,000 MW, 95 per cent. of which would be in coal, oil or nuclear fuel stations.

Technically, there would be a move towards higher steam pressures and temperatures and to larger units, but the speed of development would largely depend on progress in research in metallurgy, heat exchange and improved cooling of generators. In transmission, the call would be for higher voltages up to the limits allowed by Corona suppression. Research in that direction, as well as in connection with submarine power cables, was of great importance. To provide cheap energy the daily and seasonable peaks must be smoothed out by finding some method of storing electrical energy, by employing pumped storage or by the exploitation of the heat pump.

TRADITIONAL AND NEW FUELS

Coal would be the chief source of fuel supply in the United Kingdom for the next generation, but could not alone meet the increased demand for energy. Even the most favourable estimates showed a minimum annual deficiency of 50 million tons by 1970 and of 70 million tons in 1979. These figures indicated the vital need for increasing the output of coal, of stopping wastage of energy and of improving the efficiency of coal utilisation plants. At the same time, they showed the importance of using other fuels whenever they gave the slightest indication of being able to compete with imported coal.

It would seem possible in 25 years' time to replace 54 million tons of coal per annum by oil, the actual rate depending on the relative costs. The ten years' programme for the construction of nuclear power stations would by 1965 result in an annual saving of six million tons with a further 1½ million tons per annum in subsequent years. If the nuclear power stations constructed during the next ten years proved capable of progressive development there was no doubt that this type of station would form a large part of the annual power programme. It was possible that the annual plant programme from 1970 onwards would amount to 3,000 MW per annum and the saving in the use of coal would therefore be substantial. Nevertheless, we should still be relying on coal for 60 to 75 per cent. of our total energy consumption and for 80 per cent. of our total fuel consumption. We must, therefore, decide to what extent oil could economically replace coal, proceed with the construction of nuclear power stations and press on with advanced development with the twofold object of ensuring a sufficiency of power for ourselves and maintaining a leading position in the construction of power plants.

Mankind's diminishing resources of fossil fuel provided the stimulus for the intensification of research which might lead to more efficient means of conversion to electrical energy. This problem must therefore for many years ahead engage the consideration of the best research minds.

Other papers submitted to the Convention and the ensuing discussions will be reported in subsequent issues of ENGINEERING.

ENGINEERS REQUIRED FOR THE NUCLEAR POWER PROGRAMME

It is four months since the publication of the Government White Paper "A Programme of Nuclear Power", and the resources of the United Kingdom Atomic Energy Authority have been marshalled to assist in carrying the plan into effect. However, increases in staff will be necessary if complete success is to be achieved, and vacancies in the various departments of the Authority's Industrial Group have recently been announced.

The Atomic Energy Authority is responsible for research and development in the field of atomic energy and for the production and processing of nuclear fuels. It is divided into three main groups: the Weapons Group, the Research Group and the Industrial Group, each of which is represented by a member of the executive under the chairmanship of Sir Edwin Plowden.

Under its managing director, Sir Christopher Hinton, F.R.S., the Industrial Group is responsible for the design, construction and operation of plants for the production of fissile material and for prototype nuclear power stations at Calder Hall and Annan. It is also responsible for advice and guidance to the industrial firms who will undertake the construction of power stations for the Central Electricity Authority, and for the pioneering, in collaboration with the Research Group, of new types of reactors.

Within the Industrial Group there are three technical branches: engineering, operations, and research and development, each under its own director. The engineering branch is responsible for the construction of such projects as the reactors at Calder Hall, Annan and Dounreay, which are commitments of the Industrial Group. The operations branch becomes responsible on completion of the plants for their operation and level of production, and also for the continued supply of fissile material.

The responsibility of the research and development branch is briefly: the removal of difficulties which may impede the attainment of full production in any part of a production plant, and the development of works processes; the provision of information to support the design of new plants and prototype reactors according to the commitments of the Industrial Group and to a programme planned in collaboration with the engineering branch; and the longer-term study of problems which arise from the production plants and from design studies.

In the research and development branch the emphasis is on "knowing how" at a particular date, and all work is planned and progressed to a given time-table in the same way as the engineering construction programmes to which the major part is intimately linked. It is research applied to industrial needs and not pure research, but in all its activities there is close co-ordination and collaboration with the Research Group at Harwell. Since it will be necessary for staff to be able to assess the probable results of experiments in hand so that design work may continue, initiative, adaptability and the capacity to absorb new ideas quickly and put them into practice will be desirable qualities.

At the Industrial Group headquarters at Risley in South Lancashire, about five miles from Warrington, there is a group which acts in an advisory capacity to the laboratories and to the design and operations branches on physical, chemical, engineering and metallurgical problems. Theoretical studies on advanced physical, mathematical and engineering problems are carried out, and process evaluations and chemical flowsheets prepared. There is a small section dealing with the planning and technical administration of the research and development branch, and a technical information service.

The location of the laboratories and their fields of activity may be summarised as follows. At the Capenhurst works on the Wirral, five miles from Chester, there is a laboratory dealing with development work in connection with the design of prototype nuclear reactors and diffusion plants. The work, which is often concerned with novel processes, involves applied physics, mechanical engineering, heat transfer, liquid-metal technology, fluorine chemistry and advanced instrumentation. The Culcheth laboratories are situated near Risley and here the main activity is the study of materials of construction and their properties with respect to nuclear reactors and associated chemical plant. The work involves, on the laboratory scale, extraction chemistry of rare and unusual metals, refractories, physical metallurgy, deformation of metals, general physics, the melting and fabrication of metals, powder metallurgy and corrosion.

At Dounreay in Caithness laboratories are in course of construction and will be located on the site of a reactor of a very advanced type. The staff will have to deal with novel problems in general, including nuclear physics, engineering, chemical processing and metallurgy. Laboratories established at the Springfields Works at Salwick in Lancashire cover laboratory and pilot, scale work on the extraction of unusual metals from their ores, the preparation of pure metals and compounds and their fabrication into components for nuclear reactors. The work involves physical and inorganic chemistry, chemical engineering, reduction of metals, powder metallurgy, casting, mechanical working, physical metallurgy, instrumentation, vacuum techniques, non-destructive testing and general physics. The Windscale Works at Sellafield on the West Cumberland coast also possess laboratories, and these deal with research and development work concerned with the design and operation of nuclear reactors and industrial chemical processes for radioactive materials. The work involves general and nuclear physics, heat transfer and fluid dynamics, chemical engineering and the chemistry and metallurgy of radio-active materials and irradiated metal.

It is self evident that the establishing of all these laboratories and departments necessarily calls for the enrollment of considerable numbers of scientists and technologically-trained personnel. The research and development branch of the Industrial Group alone has vacancies at the different locations for chemists, chemical engineers, metallurgists, physicists, mathematicians and engineers, and the five laboratories together have a scientific and experimental complement of approximately 800. The wide range of research to be carried out is indicative of the opportunities available for work of an interesting and satisfying nature. It is moreover work which will help to keep Britain abreast of developments in the field of nuclear power production.

PERSONAL

SIR JAMES CHADWICK, M.Sc., Ph.D., D.Sc., F.R.S., has been elected an honorary Fellow of the Institute of Physics, 47 Belgrave-square, London, S.W.1.

DR. RICHARD VAN DER RIET WOOLLEY, O.B.E., F.R.S., Commonwealth Astronomer and Director of the Commonwealth Observatory, Canberra, Australia, is to succeed SIR HAROLD SPENCER JONES, K.B.E., Sc.D., D.Sc., F.R.S., in the post of Astronomer Royal, Royal Greenwich Observatory, when the latter retires from the Public Service on December 31, 1955.

SIR ROGER DUNCALFE, President of the British Standards Institution, has been elected the fourth President of the International Organisation for Standardisation (ISO). He will hold the Presidency for three years from January 1, 1956.

DR. A. PARKER, C.B.E., Director of Fuel Research, Department of Scientific and Industrial Research, has been elected chairman of the Council of the Royal Sanitary Institute, 90 Buckingham Palace-road, London, S.W.1.

MR. W. W. FRANKLIN, M.I.Mech.E., the chief engineer and a director of Davy and United Engineering Co. Ltd., Park Iron Works, Sheffield, 4, assumes the position of technical director as from to-day, July 1. MR. J. B. BUCHER, Dip.Ing., A.M.I.Mech.E., M.I.E.S., is appointed chief engineer responsible to Mr. Franklin with effect from the same date.

MR. J. M. WALDRAM, senior research illuminating engineer of the General Electric Co. Ltd., is to be inducted as President of the Association of Public Lighting Engineers at the annual conference at Folkestone, to be held from September 13 to 16.

The Minister of Transport and Civil Aviation has appointed MR. J. EMLYN JONES, O.B.E., T.D., B.Sc., A.M.I.C.E., A.M.I.Struct.E., to be divisional road engineer, Scotland Division, in succession to MR. J. A. BURNETT, C.B.E., M.I.C.E., A.M.I.Mun.E., who is retiring on October 31.

Lloyd's Register of Shipping, 71 Fenchurch-street, London, E.C.3, announce that MR. S. T. BRYDEN, M.Sc., principal surveyor for freeboard on the chief ship surveyor's Staff at headquarters and MR. A. G. AKESTER, M.Sc., principal surveyor at Greenock retired on June 30. MR. H. MCQUEEN, M.B.E., senior ship surveyor at Glasgow, is to succeed Mr. Akester at Greenock. MR. G. ANDERSON, senior surveyor at Birmingham, retired on June 30 and is to be succeeded by MR. L. D. TRENCHARD from headquarters. MR. S. ARCHER, M.Sc., has been appointed a principal engineer surveyor as from July 1.

MR. C. W. GLOVER, M.I.C.E., M.I.Mech.E., M.I.Struct.E., M.Cons.E., practising as C. W. Glover and Partners, consulting engineers and architects, Francis House, Francis-street, London, S.W.1, has now taken into partnership MR. D. W. CRACKNELL, A.M.I.C.E., A.M.I.Struct.E., MR. C. A. BUSHELL, A.I.A.S., MR. R. H. ROWE, A.I.Mech.E., MR. W. F. GRESSWELL, A.M.I.E.E., and MR. V. E. HOLLOWAY, M.I.R.E. The firm is in professional association with MR. G. J. GUMERSALL, B.Sc., M.I.C.E., M.I.Med.E., M.I.Struct.E., M.I.E.E., MR. L. L. LIPSKI, F.R.I.B.A., A.I.A.S., A.A.Dip., and MR. M. G. S. SWALLOW, M.I.E.E.

ASTON MARTIN LTD. and LAGONDA LTD., which are incorporated in the Automobile Division of the DAVID BROWN GROUP, have reconstituted their boards of directors as follows: MR. DAVID BROWN, who is chairman and managing director of the David Brown Corporation Ltd., and MR. A. AVISON, MR. E. J. BATCHELOR, MR. F. B. MARSH, MR. J. STIRLING and MR. J. WYER.

MR. S. H. IRELAND, who rejoined the Small Heath Group of the B.S.A. Company Ltd., Birmingham, 11, in February, has been appointed general works manager on the retirement of MR. J. A. T. DICKINSON, O.B.E., referred to on page 751, *ante*. MR. HERBERT HOPWOOD, chief designer, B.S.A. Motor Cycles Ltd., for the past six years, has been appointed chief engineer, Birmingham Works, in succession to MR. H. FAULKNER. Mr. Faulkner reached the retiring age last month, but will continue to serve the company for another year.

MR. W. K. TATE, M.A. (Cantab.), M.Inst.Gas E., who recently completed his year of Presidency of the Institution of Gas Engineers, is joining the board of Thomas Glover & Co. Ltd., to-day, July 1, in the capacity of managing director. He is also joining the board of the parent company, Glover and Main Ltd., 48 Grosvenor-gardens, London, S.W.1.

MR. D. H. LEESON, M.A. (Cantab.), A.M.I.E.E., has joined Crompton Parkinson Ltd. as home-sales manager of the company's associate switchgear concern, Cooke and Ferguson Ltd. He will operate from Manchester.

MR. H. H. DAKER, B.Sc., A.M.I.E.E., C.P.A., has been appointed patents officer to British Insulated Callender's Cables Ltd., in succession to the late MR. R. L. CLEAVER.

MR. E. R. SISSON, A.R.Ae.S., has been appointed technical services manager to Smiths Aircraft Instruments Ltd., Cricklewood, London, N.W.2, in succession to the late Mr. L. R. LANGMEAD.

MR. C. STEPHENSON, general manager of Hawthorn Leslie (Shipbuilders) Ltd., and MR. C. N. STOREY, secretary, Hawthorn Leslie (Shipbuilders) Ltd., and Hawthorn Leslie (Engineers) Ltd., have been elected directors of the parent company, R. and W. Hawthorn, Leslie & Co. Ltd., St. Peter's Works, Newcastle-upon-Tyne, 6, and its subsidiary companies. MR. D. G. OGILVIE, general manager of Hawthorn Leslie (Engineers) Ltd., has been elected to the board of that company.

MR. R. C. NASH, chief assistant to the managing director of Edwin Danks & Co. (Oldbury) Ltd., has retired owing to ill health.

MR. J. W. JACKSON has been appointed manager, Dublin sub-office, Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17. MR. T. J. HORGAN remains the company's adviser in Eire.

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COMMERCIAL

Negotiations have been completed between the PESCO DIVISION of the BORG WARNER CORPORATION, of America, and PLANNAIR LIMITED, Leatherhead, Surrey, for the manufacture, under licence in the United States, of axial-flow fans and blowers.

THE GENERAL ELECTRIC CO. LTD., is transferring the production of domestic radio receivers from their Spon-street works to another factory in Coventry. They are devoting to television production the whole of the manufacturing space previously occupied by domestic radio production.

The new address of MANCHESTER REPETITION ENGINEERS LTD. is Alexander-street, Hyde, Cheshire. (Telephone: 1811)

THORN ELECTRICAL INDUSTRIES LTD. have purchased the ordinary share capital of H. HERRMANN LTD. MR. H. J. RUSSELL has resigned from the board and MR. ALFRED DEUTSCH and MR. R. E. DAVIS of Thorn Electrical Industries have been elected thereto. It is intended that the Herrmann group will continue, as heretofore, to manufacture radio and television cabinets.

A new company has been formed by HOLMAN BROS. LTD. as a result of developments in connection with dust and fume prevention in industry. The new subsidiary concern, the DUSTUCTOR CO. LTD., will manufacture and develop the Dustuctor low-volume, high-velocity system of dust, fume, flock and vapour extraction. Research and manufacture will be carried out at Hayle, Cornwall. The chairman is MR. A. T. HOLMAN, the general manager MR. F. F. L. MORGAN and the development engineer MR. E. B. JAMES.

WICKMAN LTD., Coventry, have acquired all the issued ordinary capital of ARTHUR SCRIVENER LTD., machine-tool manufacturers, Tyburn-road, Birmingham.

EASTERBROOK, ALLCARD & CO. LTD., manufacturers of small tools, Sheffield, 6, are opening a new stocking warehouse during the first week of the present month at East India House, Helena-street, Parade, Birmingham, 1. (Telephone: Central 6997.) MR. P. E. PICKERING has been appointed sales representative covering the Midlands. Communications should be addressed to him at East India House.

THE FEDERATION OF CHAMBERS OF COMMERCE OF THE BRITISH EMPIRE has confirmed an earlier decision to change the Federation's title to that of the FEDERATION OF COMMONWEALTH AND BRITISH EMPIRE CHAMBERS OF COMMERCE, 69 Cannon-street, London, E.C.4.

A branch of the NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE has been set up, with the support of the Northern Ireland Ministry of Commerce, in Belfast.

LEYLAND MOTORS LTD., Leyland, Lancashire, have appointed OY SUOMEN AUTOTEOLLISUUS AB, Fleminggatan 27, Helsinki, to be their agent in Finland.

PERMALI LTD., 125 Bristol-road, Gloucester, announce that, following negotiations with JABLO PLASTIC INDUSTRIES LTD., they have registered two new subsidiary companies, namely, HYDULIGNUM-JABROC (TOOLS) LTD., designers and manufacturers of metal-forming tools and jigs for the aircraft and engineering industries, with works at Mill-lane, Waddon, Croydon, Surrey; and JABROC LTD., for the manufacture of densified wood laminates, also with works at Mill-lane, Waddon, Croydon, Surrey. The management of both companies is under the direction of MR. J. H. COLLINS, B.Sc., F.R.I.C. Permali Ltd. also announce that a new factory for their densified wood laminates is to be built at Mount Pleasant, 32 miles south-east of Pittsburgh, Pennsylvania, U.S.A. The present location of the American subsidiary company, PERMALI INC., is 55 West 42nd-street, New York.

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OBITUARY

We regret to record the death of:

MR. LOUIS GEORGE VEDY, C.B.E., on June 18, at the age of 59. He was an assistant secretary of the Ministry of Fuel and Power and had been in the Civil Service for nearly 43 years, during the course of which time he served in the War Office, the Board of Trade and the Ministry of Labour. He was seconded to the Ministry of Fuel and Power in 1942. In 1947 he became administrative head of the Fuel Efficiency Branch of the Ministry and was later loaned to the National Industrial Fuel Efficiency Service as commercial manager.

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CONTRACTS

Fuel Oil for Power Generation. A contract has been signed between the Central Electricity Authority and Esso PETROLEUM CO., LTD., for the supply of fuel oil to seven power stations. The contract is additional to the agreement reached in July, 1954, for the supply of fuel oil from the company's Fawley refinery to the new Marchwood power station on Southampton Water. The decision of the Authority to equip a number of new power stations for oil firing, and to adapt others for oil firing as an alternative to coal, arises from the anticipated increasing shortage of coal in the future. It is estimated that the present annual rate of coal consumption in the Authority's power stations of some 37 million tons, will increase to 50 million tons per annum by 1960. In that year, the consumption of fuel oil under the new contract will have increased to rather more than 2·5 million tons, equivalent to between 4 and 5 million tons of coal. The seven power stations scheduled for oil firing are Littlebrook, Tilbury, Barking and Brunswick Wharf, all on the Thames and its estuary, and Poole, Plymouth and Portishead, near Bristol. All are conveniently situated for oil delivery direct from coastal tankers.

Cargo Motorship. An order for a 9,920-ton deadweight open shelter-deck (10,820-ton closed shelter-deck) cargo motorship, for the Monarch Steamship Co. Ltd. (Raeburn and Verel Ltd., managers), Glasgow, has been received by BARTRAM & SONS LTD. The principal dimensions are length, between perpendiculars, 425 ft., extreme breadth 58 ft. 9 in., depth moulded to shelter deck 38 ft., and 29 ft. 6 in. to main deck and draught 26 ft. 1 in. The propulsion machinery will consist of a KINCAID/B. & W. Diesel engine developing 2,600 b.h.p. at 110 r.p.m. giving a service speed of 11¼ knots. The auxiliary machinery will be steam driven.

Radio Mast. The British Broadcasting Corporation announce that they have placed a contract with J. L. EVE CONSTRUCTION CO. LTD., 17, Hillside, London, S.W.19, for the design, supply and erection of the 560-ft. stayed mast for the television and very-high-frequency sound-transmitting station which is to be built at Blaen Plwy, Cardiganshire, to serve the coastal areas of West Wales. Design work will start at once and it is hoped that the mast with its aerials will be completed so that the station can be ready for service towards the end of 1956.

Electric Railway - Traction Equipment. Electric-traction equipment valued at about £900,000 has been ordered from ASSOCIATED ELECTRICAL INDUSTRIES (INDIA) LTD., by JESSOP & CO. LTD. This firm is supplying 104 railway coaches for broad-gauge multiple-unit trains on the Calcutta electrification scheme of the Indian Government Railway Board. The new rolling stock will comprise 34 three-coach units, each consisting of two driving trailer coaches with a motor coach between. Two spare motor coaches have also been ordered. The bulk of the electrical equipment will be made by METROPOLITAN-VICKERS ELECTRICAL CO. LTD. at their works at Sheffield and Trafford Park, Manchester, 17. Approximately 10 per cent. of the electrical equipment will be manufactured in India by A.E.I. MANUFACTURING CO. LTD.

Book Reviews

PRE-CAST CONCRETE: INCREASING USE FOR LARGE MEMBERS

Precast Concrete. By PROFESSOR DR.-ING. KURT BILLIG. *Macmillan and Company, Limited, St. Martin's-street, London, W.C.2.* (32*s.*)

During the past ten years there has been a very marked increase in the use of structural pre-cast concrete members in building and civil engineering construction in all countries. The outstanding developments are the very great increase in the size of prefabricated structural members now employed, and the improved quality of the product due to the increased control of concrete making and placing. Speed of erection, combined with economy in cost, can be achieved by pre-casting either in a factory or on the site.

The pre-casting of concrete members has been established practice for many years, and its field of use at the present time extends from the production of small units such as blocks, kerbs, sills, lintels, tiles and pipes to posts, columns and floor units of a wide variety of length and section, and beyond into structural frames and bridges of very large span. Prior to the war, it had been adopted on a somewhat limited scale for single-storey buildings of moderate span. The war-time demand for additional building for military and factory use encouraged development which has continued in the post-war period and has been additionally boosted by the developments in pre-stressed concrete.

The smaller units are normally made in factories where machinery and control can be efficiently utilised and where the labour force can be trained and retained. Special curing arrangements can be provided economically to allow quick release and re-use of moulds. Noticeable improvements in this field include the production of better quality concrete of greater uniformity, together with an expansion of production through more efficient mechanisation. Concrete sections are necessarily rather bulky, and handling and transport arrangements need careful consideration, especially with the larger units. In recent years there has been a tendency on major products to take the plant to the site and to pre-cast the large structural units alongside their final position and erect by means of site cranes. Economies resulting from repetition can be fully utilised and, due to the rapid rate of erection, overheads and site supervision are reduced.

While the economies produced by the use of pre-cast concrete arise mainly from the reduction in shuttering and scaffolding which are always an expensive part of normal structural concrete, the improvements in hoisting equipment and methods have had a marked effect in recent years. Pre-cast concrete can now claim that it is employed on an increasing scale as a structural material in its own right, although in total volume it still remains only a fraction of that of *in situ* reinforced concrete.

With such a large variety of uses the number of articles which have appeared in the technical journals on pre-cast concrete construction has naturally been extensive, but there has not previously been a general text-book dealing with the system as a whole, and Dr. Billig attempts to fill this gap. Professor Kurt Billig is now the Director of the Central Building Research Institute of India, and he has been able to draw on his pre-war experience in the U.S.S.R. and on his work in this country during the war. One of the great difficulties in the production of a text-book on a subject which is rapidly developing is that much of the material may become outdated or improved upon before the book is published, and some sections of his book suffer in this way. This is particularly noticeable in relation to factory buildings, housing systems and bridgeworks, where the absence of recent examples is to be regretted.

But the book as a whole contains much of value to products manufacturers and to the engineer in both the design and construction fields. It is divided conveniently into four parts, the first dealing with methods of design, production processes, treatment of pre-cast concrete, and transport and erection problems. The second part deals with the wide range of pre-cast units and structural members and the development of surface finishes. The methods of forming joints between members, and their efficiency, is very fully discussed in the third part, while the final section describes a variety of engineering structures utilising pre-cast members or a combination of such members with *in situ* concrete. The book contains nearly one hundred diagrams and illustrations and additional references are provided at the end of each chapter. In preparing a survey of this industry, the many patents and systems in use necessitate a certain amount of selection, and the factors affecting development vary in each country, yet there is a large field of common ground which Dr. Billig has comprehensively covered in this book.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electrical Equipment for the Oil Industry. METROPOLITAN-VICKERS ELECTRICAL CO. LTD., Trafford Park, Manchester. Electric Motors and Associated Equipment for the Oil Industry is a 200-page quarto-book describing in detail the various types of flameproof electric motor ranging from fractional sizes up to 1,250 h.p. Dimensions and performance are given for each type. Full descriptions are also given of associated flameproof equipment, brakes, gear units, starters and fittings. A separate section of the book lists non-flameproof types, including motors from ¼ to 3,000 h.p., circuit-breakers up to 11 kV, switches, starters, transformers and welding equipment. There are also sections dealing with characteristics, construction and operational details.

Rotary Compressors and Vacuum Pumps. WHITTAKER, HALL & CO. (1929) LTD., Black-lane Works, Radcliffe, Manchester. Rotary sliding-vane compressors and vacuum pumps; displacements from 2 to over 2,000 cub. ft. per min. Pressures up to 120 lb. per sq. in. and vacuums to 28 in. of mercury. List of models.

Nitrogen Plants. H. E. CHARLTON (ENGINEERS) LTD., 38 Clarendon-road, Eccles, Manchester. Plants for the production of liquid and gaseous nitrogen from air. Leaflet.

Micropowder Magnets. SALFORD ELECTRICAL INSTRUMENTS LTD., Silk-street, Salford, 3, Lancashire. Uses of moulded Gecalloy micropowder magnets. Leaflet GM.M. 5504/6.

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BRITISH STANDARDS

The following publications have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2 Park-street, London, W.1, at the price given after each title.

Aluminium-Alloy Sections (for marine purposes). (3*s.* 6*d.* post free.)

A new specification, B.S. 2614, covering aluminium-alloy sections, is complementary to B.S. 1161 which deals with aluminium and aluminum-alloy sections. The new standard defines three series of structural sections designed mainly for marine use. The sections result from some two years of intensive development work, which took into account forming behaviour and modern welding techniques. Three types of sections are tabulated and, for the 4-in. size and upwards, alternative thicker webs are listed for use where necessary. These sections are: bulb angles for riveting, T-bars for welding, and bulb plates for welding. The first are of conventional type but with profiles adapted for the economical disposition of metal. The T-bar was chosen as an efficient symmetrical shape and the bulb plates for welding are similar to the bulb angles for riveting. They are of conventional shape, and facilitate the application of brackets. Both the welding series of sections have a small root bead or table for welding. The dimensions have been fixed so that these can be used as backing bars for butt joints.

Glossary of Terms used in Radiology. (10*s.* post free.)

Another new standard, B.S. 2597, is entitled "Glossary of Terms used in Radiology," and is intended as an authoritative work of reference for medical and industrial radiologists and for general workers in radiology. It contains over 750 terms and definitions and its four main sections are: general terms and physics; sources of ionising radiation; radiography and fluoroscopy; and radiotherapy and radiation protection. Where appropriate quantitative values and symbols are given for the various terms. A complete alphabetical index is included.

Canadian Welding Qualification Code. (Obtainable on request.)

Considerable efforts have been made by the British Standards Institution to help exporters of engineering equipment to meet the various standards and certification requirements existing in Canada. Further assistance is now available as the result of arrangements completed for the certification, in this country, of welded fabrications destined for the Canadian market. A booklet designated PD 2179 and entitled "Information on the Canadian Welding Qualification Code" has recently been published. This sets out, in detail, both the procedure adopted in Canada for the certification of welded fabrications and the arrangements now agreed upon for carrying out this work in the United Kingdom. The new facilities, however, do not affect the existing arrangements with regard to the export to Canada of boilers and pressure vessels and the necessary investigation and certification of these items. All queries shuld be addressed to the Principal Officer, B.S.I./C.S.A. Approvals Agency, British Standards Institution, 2 Park Street, London, W.1.

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CHANGES IN SHIP CONSTRUCTION RULES

Certain modifications and re-arrangements of the constructional rules of the Society are announced by Lloyd's Register of Shipping, 71 Fenchurch-street, London, E.C.3, in their Notice No. 2054. The present requirements for welded construction of steel ships, contained in Sections 31 and 33, and in Section 34, paragraphs 3421 to 3427, have been revised and embodied in a new Section 31. The requirements for riveted construction, at present contained in Section 32, and Section 34, paragraphs 3401 to 3420, have been collected and re-arranged in Section 32.

Rules have been adopted for ships specially designed for the carriage of ore cargoes; that is, for the modern type of ore carrier with machinery aft, deep double-bottom and two longitudinal bulkheads forming central ore holds, with side tanks for either water ballast or oil. A new class 100A1 ore carrier has been introduced to indicate the service for which these ships have been designed and approved. If the scantlings and arrangements are suitable, existing ships converted into, or originally constructed as, ore carriers can, if desired by the owners, qualify for this new class.

As is well known, ships which comply with the normal requirements of the rules are suitable for the carriage of dry and perishable cargo of all types, including heavy cargoes such as ore, but as many owners prefer to have some additional strengthening for ships employed regularly in the carriage of heavy cargoes, recommendations as to the most suitable form of strengthening are now available for their guidance.

Some six months ago the society's rules for the construction of refrigerated cargo installations were completely revised and alterations have now been made in the Regulations for their classification and periodical survey.

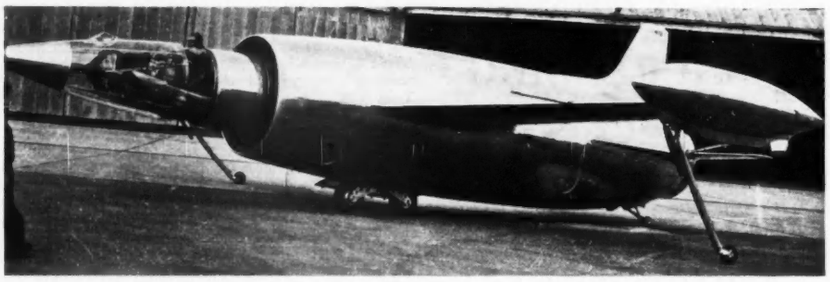


Fig. 10

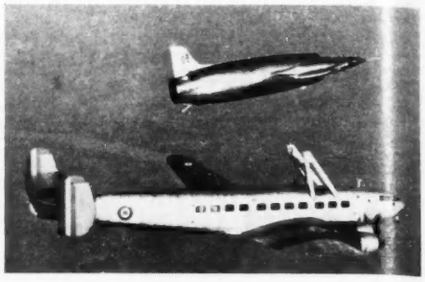


Fig. 11

The Leduc O-21 research aircraft, powered by a ram jet, paves the way for the Leduc O-22 fighter which is expected to attain Mach 2.

FRENCH AIRCRAFT DEVELOPMENTS

RESEARCH AND MILITARY MACHINES AND PROJECTS

Concluded from page 803 (*vol.* 179)

In the two previous articles on French aircraft developments we described some of the light jet training and communications aeroplanes (page 772, June 17 issue), and transport aircraft and helicopters (page 801, June 24 issue). In this final article, we shall mention some of the principal military machines and research aircraft, and some projects for the near and not-so-near future.

LEDUC O-21 RAM-JET AEROPLANE

Possibly the most important of France's post-war contributions to aeronautics is the development of the ram-jet-powered piloted aircraft by René Leduc et Fils, 158, Quai de Bezons, Argenteuil (Seine-et-Oise). The Leduc O-21, shown in Fig. 10, was scheduled to appear on a carrier aircraft in the flying display on the last two days. It is launched from its carrier aircraft, the Languedoc 161, at about 190 m.p.h., at which speed the ram jet becomes operable (Fig. 11).

M. René Leduc began his studies on the ram-jet, or thermo-propulsive duct, in 1930. Construction of the first full-scale Leduc ram-jet, the O-10 aircraft, was interrupted by the second World War; the existence of the project was concealed from the Germans, and after the war development was taken up again. The first piloted flight of an aircraft propelled by a ram-jet was carried out on April 21, 1949. Two prototype O-10 aircraft were built, followed in 1951 by a more powerful machine, the O-16, and then two prototype O-21 aircraft, the first in March, 1953, and the second about a year later. These O-21 aircraft have provided the experience necessary for designing a supersonic intercepter aircraft, the Leduc O-22, which is expected to attain a speed of Mach 2 and which will probably fly before the end of this year.

In the Leduc O-21, the entire fuselage comprises the thermo-propulsive duct. Air enters a divergent nozzle formed between the fuselage wall and a central body, to the main structural member of which are attached the wings. The forward part of the central body comprises a pressurised cockpit in which the pilot is seated. The whole of the cockpit can be jettisoned, and cockpit parachutes are accommodated behind the cockpit pressure bulkhead, as is also an emergency oxygen supply. In the rear part of the central body is located the fuel pump which is driven by a Turboméca Artouste shaft turbine, the exhaust of which serves as an igniter torch for the ram-jet burners.

Aft of the centre body are six shrouded burner rings of progressively increasing diameter, forming a stepped conical combustion chamber, each burner ring dealing with a charge of unburnt compressed air. In each ring are three sets of burners, the fuel supply to each being controllable by the pilot thus providing a choice of three thrusts.

There is a clear air space between the final and largest burner shroud and the inner wall of the fuselage duct to provide an insulating layer of cold air between the latter and the exhaust jet.

Fuel is carried between the double walls of the centre part of the fuselage, and in the main wing torsion box, but not in the wing-tip nacelles, which are used during flight trials for housing test instrumentation. The undercarriage, hydraulically operated, comprises main wheels in tandem supported from the main member of the central body, and retracting fore and aft into the fuselage duct; outrigger wheels at the wing tips retracting into the tip nacelles; and a non-retracting tail wheel. The plain trailing-edge flaps and the powered controls also are hydraulically actuated.

The principal particulars of the Leduc O-21 are as follows: wing area, 237 sq. ft.; span, 38 ft.; overall length, 41 ft.; height, 9 ft. power developed at 620 m.p.h. at sea level, about 20,000 h.p.; weight empty, 8,380 lb.; all-up weight, 13,200 lb.; maximum permissible Mach number, 0·85; sea-level climbing speed, 39,300 ft. per minute.

As already noted, a supersonic ram-jet aircraft is now under construction, and a number of components of this machine were on view on the Leduc stand, among which may be mentioned part of the wing structure, showing how the wing skin is built up from sections of thick sheet bolted together, the stringers being formed by machining before assembly. The Leduc company were, it is believed, one of the first to adopt integral construction. Indeed the advanced conception of the Leduc aircraft has resulted, of necessity, in the company developing their own techniques for most of the equipment—for example the launching gear, the jettisonable cockpit, the unconventional undercarriage, and the hydraulic servos for the powered controls which, manufactured by Ets. Paul Jacottet, Courbevoie, are now incorporated on most French high-performance aircraft. Since no fuel pump was available with the required flow characteristics—4·4 gallons per second at 570 lb. per square inch—M. Leduc has designed for the O-22 a complete turbo-pump unit which also provides the drive for all the auxiliaries through a reduced gearbox.

Fig. 12 Believed to be the smallest delta-wing aeroplane yet constructed, the Payen Pa. 49 is of wooden construction and is a 280-m.p.h. flying scale model for a future light fighter aircraft.

THE DASSAULT LIGHT-WEIGHT FIGHTERS

This year two French delta-wing aircraft were on view for the first time at le Bourget—the second prototype Gerfaut 1402B, and the Payen 49—and the first flight of another delta prototype, the Dassault MD. 550, was imminent. This latter aircraft, designed and constructed by Avions Marcel Dassault, 46 Avenue Kléber, Paris (16) is the forerunner of a future family of light-weight interceptors and ground-attack aircraft designed for operating from forward airfields where runways and other facilities are primitive. Very little information has been released on the MD. 550, but it is known that the power units are two Viper jet engines constructed by the Dassault company under licence from Armstrong Siddeley Motors Limited, weighing 495 lb. and giving a maximum thrust of nearly 2,200 lb. each with their Dassault afterburners in action. Another Dassault light-weight tactical support aircraft project, the Mystère XXII, was shown in model form on the company's stand at the Salon. This also is a twin-jet machine but not a delta. It has a very sharply swept-back wing of thin section. Both these aircraft will have an all-up weight less than 11,000 lb.

NORD GERFAUT DELTA-WING AIRCRAFT

The first prototype Gerfaut was designed and constructed by Société Française d'Etudes et de Construction de Matériels Aéronautiques Speciaux. Development has now been taken over by Société Nationale de Constructions Aéronautiques du Nord, 12, Rue Béranger, Châtillon-sous-Bagneux, and the first production aircraft—the Gerfaut 1405, is expected to fly early next year.

The Gerfaut is an experimental supersonic aircraft. The first prototype exceeded the speed of sound in level flight, without the use of afterburning or rocket power, in August last year and is believed to be the first single-seat aircraft to achieve this feat. The later Nord

version, which has a larger wing area than the first prototype and is powered by a 6,600-lb. thrust, Atar 101 D in place of the Atar 101 C has also exceeded Mach 1 in level flight.

The wing, which is very thin, is of riveted construction and has two main spars, all machined, and two auxiliary spans forming leading-edge and trailing-edge torsion boxes which are stiffened by means of pierced sheet ribs the main undercarriage units retract inward between the main spars. Separate elevator and aileron flaps are power-operated by means of Jacottet-Leduc hydraulic servo-controls. On the prototype the rudder is manually operated but in the production machine this also will be power operated. The all-moving tailplane, set high on the fin, provides for longitudinal trim and is electrically actuated. The control surfaces are of Sandwich Construction with light-alloy skins filled with Klégécell, an exceptionally light and strong porous synthetic resin.

The fuselage is pressurised and is provided with an ejector seat and a braking parachute. Air brakes are fitted on either side of the rear fuselage. The Messier undercarriage has Ministop anti-skid brake control units—a mechanism in which, when skidding occurs, an inertia weight actuates solenoid valves cutting off the supply of hydraulic fluid to the brakes until skidding has ceased.

The production Gerfaut will be powered either by a 3,800-kg. Atar 101 F12 turbojet or a 4,400-kg. Atar turbojet, both of which have provision for afterburning. For this reason the fuselage will be bigger both in diameter and length. In addition a SEPR liquid-fuel rocket motor will be installed in a cell below the belly. At sea-level structural considerations will limit the speed to Mach 0·9, but at altitude, it is expected that, with afterburner and rocket motor in action, a speed of Mach 1·7 will be attained.

PAYEN PA.49 DELTA-WING AIRCRAFT

The smallest delta-wing aeroplane yet constructed is believed to be the Payen Pa.49 experimental machine designed and constructed by Ets. N. R. Payen, 242 Rue de Rivoli, Paris (1). Indeed, the cockpit is so small that it is something of a mystery how the pilot disposes himself therein. In fact, the Pa.49 is not a true delta since there is a slight sweepback on the trailing edge, but it has the sharply swept-back leading edge (70 deg.) and low-aspect ratio (2·7) characteristic of the delta wing (Fig. 12).

Of wooden construction, the Pa.49 is a flying scale model for a future light fighter aircraft. It is powered by a 350-lb. thrust Turboméca Palas jet engine, with wing-root intakes, and is provided with a fixed undercarriage. The leading particulars are as follows: wing area, 121 sq. ft.; span, 15·5 ft.; length, 15·4 ft.; height, 6·7 ft. The weight empty is 1,015 lb., and the all-up weight is 1,433 lb. The aircraft has a maximum speed of 280 miles per hour and climbs at 1,140 ft. per minute. The maximum range is 280 miles, and the absolute ceiling 27,890 ft.

The Pa.49 is a tail-less machine, controlled by separate elevator and aileron flaps on the wing trailing edge. The elevator flaps are provided with trim tabs. An interesting feature of the machine is the rudder, which is split on the longitudinal vertical plane so that each half can be opened out to form air brakes, electrically-actuated. By this means the landing speed can be reduced by about 25 per cent.

Fig. 13 The Dassault Super-Mystère supersonic interceptor is on order for the French Air Force, who are currently equipped with Mystère IVA machines made by the same company.

BREGUET LIGHTWEIGHT FIGHTER

S. A. des Ateliers d'Aviation Louis Breguet, 24 Rue Georges Bizet, Paris (16), also showed models of two lightweight fighter aircraft, the Breguet 1001 Taon single-jet aircraft, which is under construction and for which the company hope to receive orders from NATO for three prototypes, and the Breguet 1100, a twin-jet machine.

The Taon, which is to be powered by a Bristol Orpheus engine, is a mid-wing monoplane with a highly swept-back wing and underwing fuel nacelles. The tail plane, also well swept-back, is set low on the fuselage. The air intake for the engine is bifurcated and placed well forward of the wing root, below the cockpit.

The twin-engine machine also has highly swept-back wing and tail surfaces. The engines are located side by side in the rear of a rather wide, flat and long fuselage. Three alternative turbojets are envisaged, the SNECMA R-105, the Hispano-Suiza R-800 or the Turboméca Gabizo.

The latter engine, which recently passed the official 20-hour qualification test, is illustrated in Fig. 19. With an overall weight of 560 lb., including an oil reservoir, a 2,500-watt generator, and an accessory gearbox with take-offs for a hydraulic pump and an afterburner fuel pump, the Gabizo develops a maximum sea-level static thrust of 2,420 lb. with a specific fuel consumption of 1·04 lb. per lb. thrust per hour.

DASSAULT SUPER-MYSTÈRE B.2 INTERCEPTOR

The French Air Force's day fighter squadrons are largely based on the Dassault Mystère variants. Twelve Mystère IVA machines, powered by Hispano-Suiza Verdon jets were scheduled to fly in formation through the sound barrier during the two final days of the Salon. The latest of the Mystère variants, the Super-Mystère which is derived from the truly supersonic Avon-powered Mystère IVB fighter, was also due to appear.

The Super-Mystère IVB1, illustrated in Fig. 13, flew for the first time on March 2 this year, and within the first three days of test flying exceeded the speed of sound in level flight on several occasions. It is powered by a Hispano-Suiza Avon RA.7 jet engine with an afterburner. Compared with the Mystère IVB, it has a more sharply swept-back wing of thinner section, and the air intake in the nose has been widened and flattened. As on the Mystère IVB and later production Mystère IVA aeroplanes, the Super-Mystère has an all-moving tailplane which gives more effective longitudinal control at transonic speeds.

An order for 200 Super-Mystère aircraft has been placed for the French Air Force; the production machines will be powered by SNECMA Atar engines fitted with afterburners.

VAUTOUR COMBAT AEROPLANE

Another aircraft likely to be in the front line of the French Air Force within the next two or three years is the twin-jet SO-4050 Vautour (described in the July 17, 1953, issue of ENGINEERING), a versatile machine designed and constructed by Société Nationale de Constructions Aéronautiques du Sud-Ouest, 105, Avenue Raymond Poincaré, Paris (16). The Vautour, production lines for which have been set up at three of SNCASO's factories, has been ordered in three versions—two-seat bomber, single-seat tactical support, and two-seat all-weather fighter. The first of six pre-production aircraft ordered, has recently been delivered to the French Air Force, and is a bomber version (Fig. 14).

Powered by two SNECMA Atar 101D jet engines developing 6,600-lb. static thrust, the Vautour is a transonic aircraft. The bomber version has a Plexiglas nose, and, it is stated, can carry an atomic weapon to a target 1,500 miles away. It has a ferrying range of over 3,000 miles. It can, moreover, carry out its bomb run at maximum speed—i.e., greater than 620 m.p.h. —and is believed to be the only bomber capable of such a performance.

The armament bay is unusually large and in all versions, the intention is to carry all the offensive weapons, including guided missiles, within the fuselage. The location of the engines in underwing nacelles facilitates engine changes and also the installation of different types of engine, afterburning, or a reverse-thrust mechanism. The third prototype aircraft, for instance, is fitted with Sapphire AS6 turbojets and one of the pre-production machines will be powered by Avons. The nacelles, incidentally, are armour-protected on the sides.

The cockpit is pressurised and equipped with ejector seats developed by SNCASO. The fuselage structure comprises four main longerons and a heavy gauge skin with no intermediate stringer. In the wing and tail surfaces, metal-to-metal bonding is employed for attaching the stringers to the skin. Razolin is the adhesive used, requiring only moderate curing temperatures and pressures.

TRIDENT " MIXED POWER " AIRCRAFT

At the 1953 Salon, SNCASO introduced their light-weight fighter conception, the SO 9000 Trident which is powered by an SEPR rocket motor installed in the rear fuselage, and two light-weight jet engines at the wing tips (ENGINEERING, July 17, 1953, vol. 176, page 74). By means of this " mixed power " formula, an aircraft which is economical in construction—metal honey-comb sandwich is largely employed —and of extremely high performance has been devolved. Earlier this year the Turboméca Marboré jet engines originally fitted were replaced by 1,650 lb. thrust Viper engines constructed under licence from Armstrong Siddeley Motors Limited, by Avions Marcel Dassault.

Test flying with the new engines began in March, and, using only a part of the available rocket-motor thrust, the Trident surpassed the speed of sound during the last stage of its climb to 13,000 metres.

The rocket engine of the Trident, constructed by Société pour l'Etude de la Propulsion par Réaction, comprises an independant turbo-priming unit and three combustion chambers, each of which can be fired separately. The total thrust is 9,920 lb. The turbo-pump unit runs on the same propellant as the rocket motor itself, i.e., furaline and nitric acid.

As a result of the promising performance of the Trident, the Technical and Industrial Department of State for Air has placed an order for two SO 9080 light interceptor fighters,

Fig. 14 The SO-4050 Vautour bomber. Three Vautour variants are ordered in quantity: bomber, all-weather fighter, and single-seat interceptor.

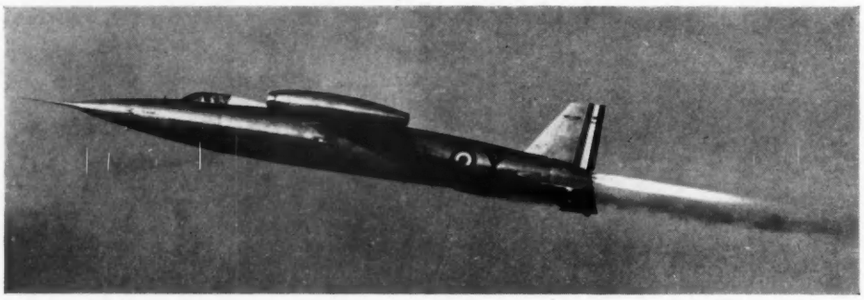


Fig. 15 The SO-9000 Trident, powered by a SEPR rocket motor and two Viper turbojets, has exceeded the speed of sound when climbing.

a development of the Trident. The first of these is expected to fly soon.

ULTRASONIC BOND TESTER

In developing their metal-to-metal bonding and metal-honeycomb-sandwich construction techniques, SNCASO have solved the problem of inspecting the bonds by using an ultrasonic flaw detector that they have developed in conjunction with the Société Française de Réalisations Ultrasoniques. This "Aerosonic" tester, is now in quantity production. It is of the single-probe type and operates on a 90/240-volt 50-60 cycle supply, consuming about 70 watts. It is tropicalised and functions correctly at 60 deg. C. in high humidity conditions.

The operating principle is as follows: a frequency modulated (250 kcs.—0·4 Mcs.) high-frequency oscillator energises the piezo-electric membrane of the probe, which in turn emits ultrasonic waves directly transmitted by contact with the element under inspection. A range commutator and tune regulator give, for thicknesses between 0·8 and 10 mm., a resonance, which increases the high-frequency tension supplied by the oscillator. The deviation of a galvanometer gives the reading for the amplified signal.

The device is tuned according to the thickness of the tested part and the presence of a defect detected by the probe upsets the resonance and moves the pointer. A more methodical examination can be made by means of a cathode oscillograph in parallel with the galvanometer.

The probe or transductor, which transforms the electrical into mechanical energy has been developed with particular care; made in polarised and metalised ceramic it can radiate an energy of 10 watts per square centimetre; it has sufficient shock-absorbing qualities to cope with parasitic resonance, while retaining an extremely high sensitivity.

Protected by a plastic cover, it has, in addition, very good friction contact qualities.

THRUST REVERSERS AND PULSE JETS

In 1953, Société Nationale d'Études et de Constructions des Moteurs d'Aéronautiques, 150 Boulevard Haussmann, Paris (8), displayed in flight the first successful reverse-thrust mechanism for turbojet engines, installed in a Goblin-powered Vampire aircraft. With this mechanism it is possible to apply a variable amount of reverse thrust for reducing the landing run of a jet aircraft, or for decelerating in flight. The importance of this invention is such that licence agreements for its development in America and in Great Britain have been taken out by the Aerojet-General Corporation, U.S.A., and the Bristol Aeroplane Company, Limited.

This year SNECMA showed a working model of the tailpipe of the Atar engine of a Dassault Mystère II aircraft equipped for thrust reversal. This installation makes possible a maximum reverse thrust amounting to 50 per cent. of the maximum forward thrust and, compared with a plain tail-pipe, incurs a thrust loss of less than 1 per cent. when the spoilers are not in action. The unit is illustrated in Fig. 18.

The installation comprises an adjustable "obstacle" and a retractable cascade of curved deflecting vanes. When reverse thrust is not desired, the obstacle is aligned to present minimum interference to the gas flow, and the cascade of deflecting vanes is retracted into a fairing, presenting no external drag.

When thrust reversal is required, the cascade is first extended, and the "obstacle" to the gas flow is progressively increased as desired. In the Mystère installation the obstacle comprises two vertical streamlined spoilers which can be rotated through a maximum of 90 deg. to cut down the nozzle area and to direct the gas flow towards the deflecting vanes, which are so arranged that the hot gas is deflected only where there are no vulnerable parts of the aircraft in its way. It is in fact essential to a satisfactory reverse-thrust application that it shall be designed for the particular aircraft it is to serve.

In the case of tailpipes equipped for afterburning, the strut-type obstacle is not a practical proposition, on account of the high temperatures prevailing. SNECMA have overcome this difficulty by employing an "aerodynamic" variable-area exhaust nozzle, in which a controlled amount of air is blown into the tailpipe to restrict the gas flow to the desired path.

The pulse jets developed by SNECMA over the last five years have now reached the stage where they are available commercially in thrusts ranging from 30 kg. to 150 kg. SNECMA pulse jets, it may be recalled, are unique in that they use "aerodynamic" valves, which, by means of resonance effects obtained by the use of a series of convergent-divergent nozzles control the gas flow in the same way as the conventional flap valve used in other pulse jets. Such flap valves operating at high temperatures are inevitably short-lived, and their elimination is clearly a considerable asset. An agreement has been reached between SNECMA and the Aviolanda company of Holland for the latter to manufacture a pulse-jet unit known as the G.P.P. (groupe propulsif pulsatoire) based on the SNECMA Ecrivisse pulse jet. This unit is to be applied in a guided missile for the Dutch navy.

HISPANO-SUIZA VERDON TURBOJET

Among the exhibits on the stand of Société d'Exploitation des Matériels Hispano Suiza, Rue du Capitaine Guynemer, Bois-Colombes, Seine, was the Verdon turbojet, power unit of the Dassault Mystère IVA interceptor, which they have developed up to a static thrust of 7,900 lb. from the 6,200-lb. thrust Rolls-Royce Tay, for which they hold a manufacturing licence. The Tay, it may be recalled, has never been developed in the United Kingdom. The thrust increase has been achieved by increasing the mass air flow through the engine, by redesigning the centrifugal compressor, the entry guide vanes and the diffuser; by modifying and simplifying the flame tubes of the nine combustion chambers; and by redesigning the axial-flow turbine and the fixed guide vanes. The 54 turbine vanes of the Verdon are in Nimonic 90 and are longer than those of the Tay. The disc, in ferritic steel, is air cooled on both faces, and in consequence it has been possible to make it some 26 lb. lighter than that of the Tay.

THE ZBOROWSKI COLEOPTER PROJECTS

An interesting possibility for the future, not yet fully verified experimentally, was illustrated by models of projected supersonic and subsonic vertical take-off "coleopters" displayed on the stand of Bureau Technique Zborowski, 1 Avenue d'Orléans, Brunoy. The coleopter comprises a barrel-shaped annular wing which is also a propulsive duct—a configuration which, the designers claim, results in substantial economies in structure and power-installation weights and a correspondingly enhanced disposable load. In the supersonic version the wing itself comprises a ramjet, and in the subsonic aircraft it houses contra-rotating propellers driven by a turbine engine, constituting in effect a ducted fan.

Dealing firstly with the ram-jet machines: M. Zborowski envisages take-off under the power of a centrally-mounted orthodox turbo-

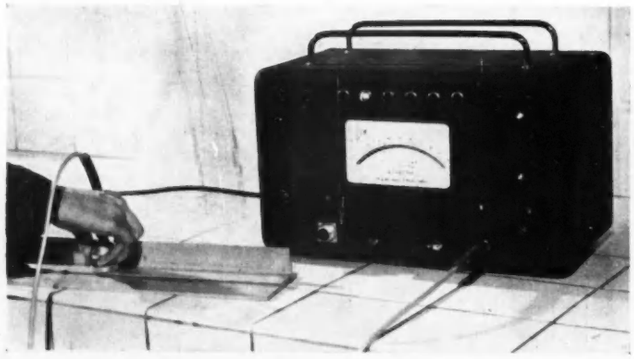


Fig. 16 The "Aerosonic" tester for checking metal-to-metal bonded joints is a single-probe ultrasonic instrument.

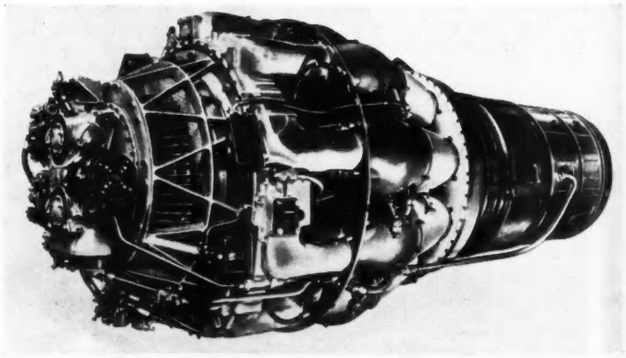


Fig. 17 The Hispano-Suiza Verdon turbojet, a 7,900-lb. thrust development of the 6,200-lb. thrust Rolls-Royce Tay, is installed in the Mystère IVA.

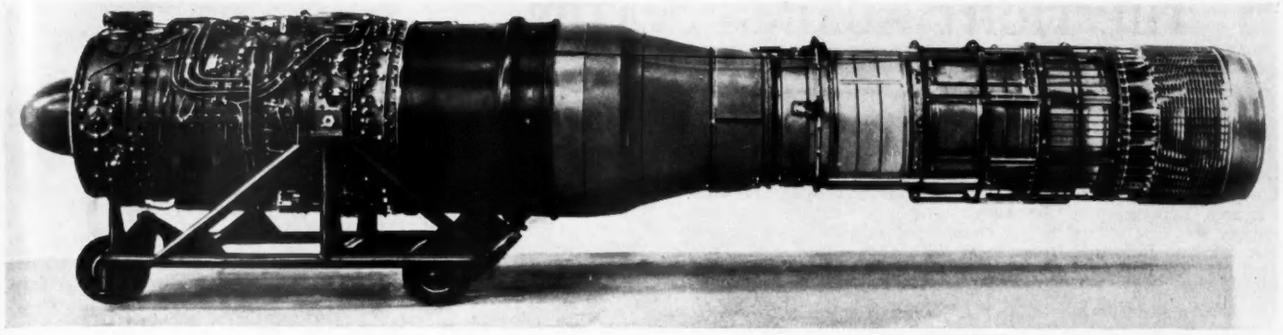


Fig. 18 The Atar jet engine of the Mystère II interceptor fitted with SNECMA thrust reverser. The retractable grill of deflector vanes is here seen extended. At the end of the tailpipe proper are two vertical spoiler struts, normally streamlined relative to the gas flow, which can be progressively rotated to direct the gas stream towards the deflector vanes.

jet, directional control and transition to horizontal flight being accomplished by means of thrust spoilers. When sufficient speed is attained, a series of burners located around the inner periphery of the annular wing are brought into action and the vehicle is then controlled by four symmetrically disposed trailing-edge flaps on the annular wing. Designed on these lines, the Bruche A project is a piloted ground-attack machine with a maximum speed of 680 m.p.h., a range of 590 miles, and an all-up weight of 7,900 lb. The maximum diameter is 8·5 ft. and the length 29·5 ft. In this aircraft the pilot would be prone in a nose cockpit forward of the turbojet, a SNECMA Atar 101G. Another ram-jet project, the Charançon VI, is a radio-controlled pilotless interceptor designed to climb to 40,000 ft. in 2 minutes, with a maximum speed of 1,300 m.p.h.

In collaboration with Société Nationale d'Etude et de Constructions des Motèurs d'Aviation, vertical take-off tests have already been carried out successfully on ¼-scale models of an annular wing, but no tests have yet been carried out with ram-jet propulsion.

Zborowski have also a subsonic touring-aircraft project, the Hanneton IIIA. This machine comprises a central nacelle in the nose of which the pilot and five passengers are seated in gyroscopically-stabilised seats so that they remain upright whatever the attitude of the coleopter. The nacelle, supported at the rear by struts, from the annular wing, houses two Turboméca Marcadau III turbines driving contra-rotating pusher propellers. Here again, flight control is by trailing-edge flaps. The maximum diameter is 13·5 ft. and the overall length is 16·4 ft. Empty, the weight is 2,850 lb., and fully loaded, 6,170 lb., giving a disposable-load percentage of 54 per cent. The cruising speed predicted is 370 m.p.h. and the range 1,240 miles.

GUST ALLEVIATION

Among other developments mention must be made of the Hirsch MAeRC.H100 experimental machine, with a wing incorporating gust alleviators. This three-seat machine, powered by two 95-h.p. Regnier piston engines, has a cruising speed of 195 m.p.h. and a range of 1,000 miles. Also of interest are the radio-controlled pilotless aircraft used as targets for guided missiles or anti-aircraft weapons, constructed by SNCAN. Two of these were on view at le Bourget—the CT10 Type ARS5501 pulse-jet-driven target shown mounted on its tractor-driven launching ramp, with a maximum speed of 280 m.p.h. at 1,300 ft., and the CT20 Type T5510 target with swept-back wing and tail surfaces, is powered by a Turboméca Marboré turbojet, and has a maximum speed of 560 m.p.h. at 32,800 ft. This craft also is launched from a mobile ramp. Both are recovered by parachute.

It is not possible to describe here many other developments in French aircraft equipment, manufacturing techniques, catapault-launching systems, and in instruments. To conclude, the growing strength of the French aircraft industry is demonstrated by the re-equipping of the French Air Force with first-line aircraft of French design and construction which is now taking place; by the fact that at least four different French machines are supersonic in level flight, of which one is already in production for the air force, one is without any auxiliary rockets or afterburning, and one can exceed Mach 1 on the climb; and by the increasing interest of other countries—including the United States and Great Britain—in French aviation developments, as shown by the various licence agreements already referred to in these articles.

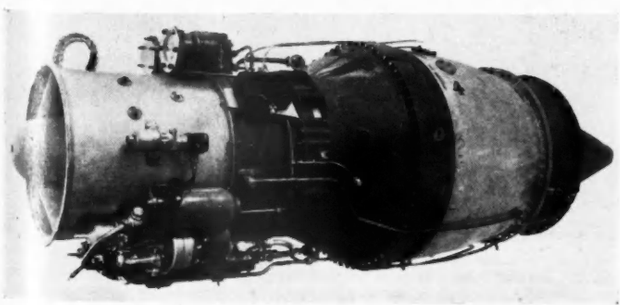


Fig. 19 The Turboméca Gabizo turbojet, which is designed for light tactical fighter applications, develops a static thrust of 2,420 lb. and weighs 560 lb.

LAUNCHES AND TRIAL TRIPS

S.S. "IVERNIA."—Twin-screw passenger and cargo vessel, built and engined by John Brown & Co., Ltd., Clydebank, for the Canadian service of the Cunard Steam Ship Co., Ltd., Liverpool. Accommodation provided for 110 first-class and 830 tourist passengers. Fitted with Denny-Brown stabilisers. Main dimensions: 608 ft. 3 in. by 80 ft. 3 in. by 42 ft. 6 in.; gross tonnage, 22,000. Two-shaft arrangement of double-reduction geared steam turbines. Trial trip, June 14 and 15.

M.S. "THORNABY."—Single-screw oil tanker, built by Sir James Laing and Sons, Ltd., Sunderland, for the Ropner Shipping Co., Ltd., Darlington. First oil tanker to be owned by this company. Main dimensions: 512 ft. between perpendiculars by 72 ft. 6 in. by 41 ft. 2 in.; deadweight capacity, about 18,270 tons on a draught of 30 ft. 6¼ in. Hawthorn-Doxford six-cylinder oil engine, constructed by Hawthorn Leslie (Engineers) Ltd., Newcastle-upon-Tyne. Engine arranged to operate on heavy oil. Speed, 14¾ knots. Trial trip, June 14 and 15.

M.S. "AYIA MARKELLA."—Single-screw cargo vessel, built by Bartram and Sons, Ltd., Sunderland, for the (C.M.L.) Maritime Co., Ltd., Chios. Main dimensions: 445 ft. 7 in. between perpendiculars by 62 ft. by 40 ft. 2 in. to shelter deck; deadweight capacity, about 10,850 tons on a draught of 26 ft. 11¾ in. Kincaid-Harland and Wolff-Burmeister and Wain six-cylinder single-acting two-stroke Diesel engine, developing 4,400 b.h.p. at 115 r.p.m. in service, constructed by John G. Kincaid & Co., Ltd., Greenock. Engine designed to burn heavy fuel oil. Service speed 13¼ knots, but speed of 15·21 knots attained on trial. Trial trip, June 15.

M.S. "HAUKEFJELL."—Single-screw oil tanker, built by Joseph L. Thompson and Sons, Ltd., Sunderland, for Olsen and Ugelstad, Oslo, Norway. Main dimensions: 530 ft. between perpendiculars by 71 ft. 10½ in. by 40 ft.; deadweight capacity, 18,250 tons on a summer draught of about 29 ft. 6 in. Six-cylinder opposed-piston oil engine, developing 6,800 b.h.p. at 119 r.p.m. in service, constructed by William Doxford and Sons, Ltd., Sunderland. Service speed, 14 knots. Launch, June 20.

M.S. "D.18."—Single-screw off-shore dredger, built and engined by the Chantiers et Ateliers Augustin Normand, Le Havre, France, for the French Navy. Main dimensions: 151 ft. 11 in. by 27 ft. 11 in. by 7 ft. 5 in.; displacement, 397 tons. First vessel of a series of six. Double-reduction geared gas turbine, developing 1,800 h.p. Speed, 15 knots. Launch, June 21.

"SHEARWATER" LIGHT VESSEL.—Built by Philip and Son, Ltd., Dartmouth, to the order of the Commissioners for Irish Lights, Dublin. Last vessel of a series of three. Main dimensions: 136 ft. 5 in. by 25 ft. by 15 ft. The lantern provides a beam 40 ft. above sea level, visible for about ten miles in clear weather. Launch, June 21.

M.S. "WYRE VANGUARD."—Single-screw trawler, built by Cochrane and Sons, Ltd., Selby, Yorkshire, for Wyre Trawlers, Ltd., Fleetwood, Lancashire. Main dimensions: 127 ft. 6 in. between perpendiculars by 27 ft. by 13 ft. 6 in.; gross tonnage, about 340. Seven-cylinder direct-reversing Diesel engine, developing 736 b.h.p. at 235 r.p.m. in service, constructed by Mirrlees, Bickerton and Day, Ltd., Stockport, Cheshire, and installed by Amos and Smith, Ltd., Hull. Launch, June 22.

M.S. "JOHN HERBERT."—Twin-screw tug, built by Henry Robb, Ltd., Leith, for the Ribble Navigation and Preston Docks Board. Main dimensions: 92 ft. overall by 23 ft. by 11 ft. 6 in.; mean draught, about 9 ft. Two five-cylinder two-stroke oil engines, developing a total of 740 b.h.p. at 300 r.p.m. in service, constructed by Crossley Brothers, Ltd., Openshaw, Manchester. Launch, June 22.

S.S. "SEPT ILES."—Single-screw ore-carrying vessel, built by The Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the Iron Ore Transport Co., Ltd., Fort Smith, North-West Territories, Canada. Main dimensions: 630 ft. between perpendiculars by 87 ft. by 45 ft. 6 in.; deadweight capacity, about 31,000 tons on a summer draught of 34 ft. One set of steam turbines with double-reduction gearing, developing 12,500 s.h.p. at 105 r.p.m. in service, constructed by Richardsons, Westgarth & Co., Ltd., Wallsend-on-Tyne. Steam supplied by two Foster Wheeler water-tube boilers. Estimated speed, 15·68 knots. Launch, June 22.

THE FIGHT AGAINST WATER POLLUTION

NEW RESEARCH LABORATORY AT STEVENAGE

On June 20 the Lord President of the Council, Lord Salisbury, opened the new Water Pollution Research Laboratory at Stevenage. The laboratory was first set up by the Department of Scientific and Industrial Research in 1927, and until 1954 was housed in a number of temporary laboratories with a headquarters at Watford. The whole staff of the laboratory is now accommodated in the new buildings at Stevenage, where, in addition to small-scale and pilot-scale laboratories, there are workshops, constant-temperature rooms, library, canteen and facilities in the grounds for large-scale experimental work on the treatment of sewage.

The main task of the laboratory is to assist in keeping the rivers of Great Britain pure. The amount of polluted water discharged into the rivers is increasing all the time, and the laboratory experiments with new and more economical and effective ways of removing impurities before effluents are discharged into rivers. The main sources of impurity are domestic sewage and industrial processes, although the disposal of radio-active waste is becoming an increasingly more important problem for the laboratory. At the opening visitors were able to see the work that is being done. It is not possible to describe it all in detail, and therefore certain items of particular interest have been selected from the total very considerable volume of work.

REMOVAL OF RADIOACTIVE WASTE

The developments now taking place in the generation of electricity from atomic energy, and in the use of radioisotopes, will greatly increase the quantity of radioactive waste materials produced. The Ministry of Housing and Local Government has asked the Water Pollution Research Laboratory to investigate the fate of radioactive substances discharged to streams, and this will be done using a section of the new Laboratory which has been specially designed for radiochemical work.

Previous radiochemical work at the Laboratory has included an investigation of the extent to which radioisotopes, which may enter water supplies as a result of attack with atomic weapons or in waste waters, are removed by the treatment processes normally used at a water works. It was found that although these processes will not remove all radioisotopes likely to be present in contaminated water, a comparatively high proportion of some isotopes is removed. For example, over 90 per cent. of the radioiodine present was removed by coagulation with alum, provided that a small quantity of silver nitrate was first added. Coagulation was not a satisfactory process for removing radiostrontium, but over 97 per cent. of this isotope was removed when the water was softened by ion-exchange.

The radiochemical section of the Laboratory also assists the work of other sections, for example in the use of " tracer " techniques for determining periods of retention in tanks, filters, and other systems. Fig. 1 shows a laboratory scale slow sand filter, which is used to determine how effective this type of filter would be in removing radioactive contamination.

CYANIDE FROM METAL-FINISHING PROCESSES

Waste waters containing cyanide are particularly dangerous and toxic, and generally it is not economic to attempt to recover cyanide for re-use in the processes. However, since the cyanide is so dangerous it must be removed, and the Laboratory is experimenting to find an inexpensive and reliable method.

The chief source of waste waters containing cyanide is the metal-finishing industry. Sodium cyanide is used in heat hardening of ferrous metals, and the cyanides of zinc, cadmium, and copper are used in electroplating with these metals. The quenching and rinsing waters from these operations are contaminated by the cyanides being used. Waste liquors from carbonisation of coal may also contain cyanide, but it is as a rule not the most important polluting constituent of such liquors.

Up to the present, chemical methods have been used for treatment of metal-finishing wastes containing cyanide. By the addition of ferrous sulphate and adjustment of the pH value with lime or other alkali, most of the cyanide is precipitated as insoluble complex cyanides of iron. The reagents mentioned are cheap and non-poisonous, and the process is widely used where complete removal of cyanide is not required, for example in pretreatment before discharge to a sewer.

For complete removal of cyanide, destruction by chlorination has to be used. In a detailed investigation of this process at the Water Pollution Research Laboratory it was found that the cyanides of sodium, potassium, zinc, cadmium and copper in strongly alkaline solution are converted first to cyanogen chloride, which is then rapidly hydrolysed in the alkaline medium to sodium cyanate, a relatively harmless compound. Several plants using this process have recently been built in this country.

As an alternative to chemical treatment, it has been found at the Laboratory that cyanide in concentrations up to about 150 parts per million can be destroyed biologically, using a percolating filter of the same type as is used for purifying sewage. From filters matured for treating cyanide, a bacterium has been isolated that can live on the cyanide. Pilot plants using the process are being tried by two commercial firms and there is a good prospect that it may find general application in the metal-finishing industry.

SYNTHETIC DETERGENTS AND FISH

One sure sign of pollution in rivers is the presence of dead fish. Fish will die either because of some toxic substance, such as cyanide, in the water, or because there is not enough oxygen in the water to support life. The absorption of oxygen occurs in a number of ways, but the most important is due to the demand for oxygen from discharged effluents; certain synthetic detergents lower the amount of dissolved oxygen in water, and their effect on fish is being studied.

During recent years there has been a great increase in the use of synthetic detergents in the place of soap. Part of the surface-active agents in these mixtures is known to pass through sewage works and so is discharged to streams with the sewage effluents. An investigation is being made to determine whether the surface-active agents are likely to have any effect on fisheries.

In laboratory experiments determinations were made of the toxicity to trout of water containing measured quantities of mixtures of seven proprietary synthetic detergents. Of trout exposed for a week some were killed when the concentration of the surface-active agent exceeded about 6 parts per million. This concentration is of the same order as that now sometimes found in sewage effluents but is considerably higher than would normally be found in a polluted river. Work is in hand to ascertain whether the toxicity in a river containing small quantities of other poisonous substances would be increased by surface-active agents in concentrations of the order known to be present in rivers polluted by sewage effluents.

The concentration of synthetic detergent in sewage is reduced during treatment at a sewage works and there may be chemical changes in those constituents discharged with the effluent. Experiments are therefore being made to determine the toxicity of effluents from the treatment in a percolating filter of a " synthetic sewage " containing known added quantities of detergents. Part of the equipment for these experiments is shown in Fig. 2. The two towers submit the sewage to the same treatment that it would have in a normal sewage works; sewage without detergent is placed in one tower and sewage with a known quantity of detergent in the other. The effluents are removed and placed in tanks containing live fish, and the effect of the effluents on the fish is then observed.

SURVEY OF THE THAMES ESTUARY

During recent decades users of the Thames Estuary have often had cause to complain of the condition of the water, particularly during the summer months. For many miles the water

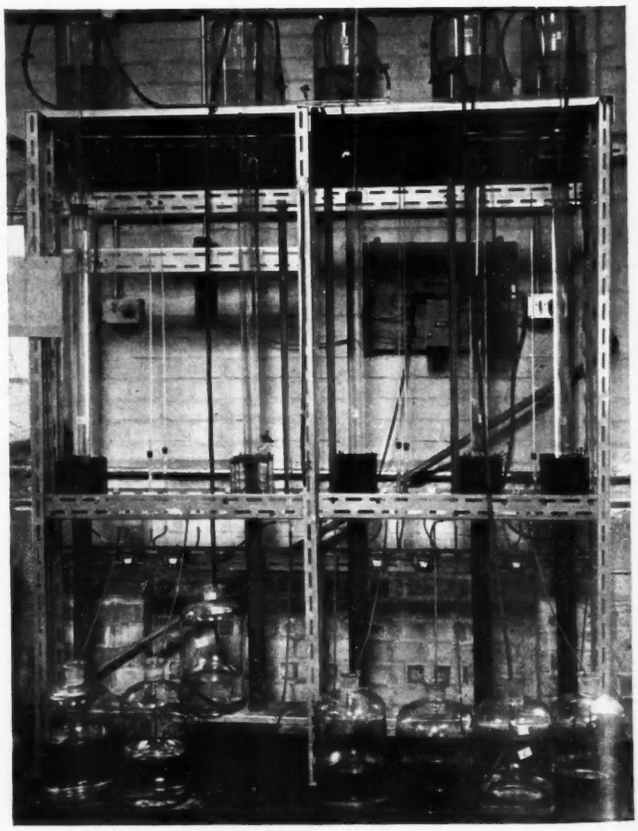


Fig. 1 To see how effective normal filtration is in removing radio-active waste this laboratory-scale slow sand filter was set up.

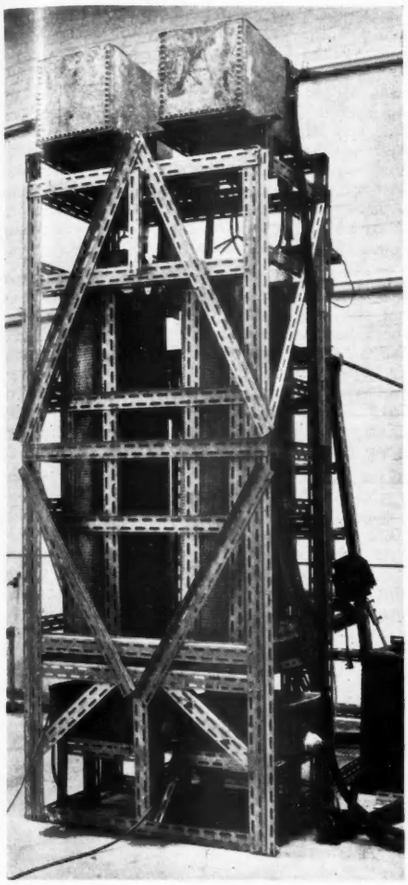


Fig. 2 These experimental percolating filters test the efficacy of normal sewage works in removing synthetic detergents. One tower is fed with pure sewage, the other with sewage and a known quantity of detergent. The effect of the two effluents on live fish is then observed.

has frequently been black in colour, foul smells have been produced, and corrosion of ships and fixed structures has occurred. This happens when there is no dissolved oxygen in the water, and hydrogen sulphide is evolved; it is most likely to happen in the July-September quarter.

In 1951 a Departmental Committee was appointed by the Minister of Local Government and Planning to consider the effects of discharge of effluents to the Estuary. The Water Pollution Research Laboratory was asked to obtain technical information to assist this Committee to reach final conclusions. It was soon confirmed that foul conditions developed only when no dissolved oxygen was present in the water and the later work was therefore concerned with an investigation of the factors which determine the rates of removal and replenishment of oxygen. The field work has now been completed and extensive calculations are in progress.

The worst conditions in the Estuary occur near the outfalls through which the partially-treated sewage of London is discharged, and it was clear that the oxygen depletion in these reaches was largely due to the presence of organic matter introduced in this effluent. Although the Departmental Committee has not yet reported, the London County Council has begun the construction of extensive plant for improving the treatment of the sewage before discharge.

To help in estimating the relative importance of various factors on the condition of the Thames Estuary, the quantity of oxygen entering the water from various sources and the amount used in oxidation has been investigated with the hope of being able to strike a balance between the two. To do this a considerable amount of experimental work has been required—for example, measurements have been made of the rate of absorption of oxygen through the water surface and of the rate of oxidation of organic matter in the water at various temperatures and salinities, and the factors affecting formation and oxidation of sulphide have been studied. The calculations required to strike a balance are still in progress but the work so far done has shown that by far the most important source of oxygen is absorption from the atmosphere through the water surface; between Teddington and Southend this probably averages about 1,000 tons per day out of a total input from all sources of about 1,200 tons per day.

When analysis of the field-work has been completed the Laboratory will issue a complete report. It is hoped that this will be early in 1956.

The new laboratory is modern in design, and the individual laboratories are extremely well equipped. An example is the smallest type of room, measuring 16 ft. by 12 ft.; services include hot and cold water, electricity, gas, compressed air, drainage in polythene pipes, fume extract, and impulse point controlled by a master clock giving impulses at 1 sec. and 30 sec. intervals. The services are concealed in false ceilings of corridors, below ground-floor corridors, in ducts betwen floors and in the upstands behind the benches. There are thermostatically-controlled electric heaters or hot-water radiators under the windows in each room, and rooms facing south have venetian blinds. Laboratory fittings include teak benches on cantilever frames with interchangeable under-bench units. There are fume cupboards with polythene-lined hoods and wall fixings for laboratory scaffolding.

ACCIDENTS ON SITE

MINES AND QUARRIES REPORT

It has many times been pointed out that very many industrial accidents are due to negligence or carelessness on the part of the workpeople involved. The latest* report of H.M. Chief Inspector of Mines and Quarries tends to confirm this. Considerably more than half of the 18 pages of the report are concerned with accidents, details being given of a variety of occurrences and in practically every case some such remark as "had the men . . . used the proper blasting shelter which was provided, the accidents would not have occurred." This, as will be clear, relates to blasting operations, but in the year 1953, with which the report is concerned the number of fatal accidents due both to haulage and transport, and also to falls of ground, were considerably larger than those connected with the use of explosives.

The number of persons employed and the outputs of minerals did not greatly differ in 1953 from the figures recorded for 1952. The total output of minerals was 165,493,000 tons, this including 11,704,000 tons of coal and 250,700 tons of fireclay at opencast coal sites. The corresponding figures for 1952 was 150,675,500; 12,167,100; and 226,500. The output per employee showed a satisfactory trend: at opencast coal workings the average output per person employed was 1,507 tons in 1953 against 1,450 tons in 1952. At other types of quarries, the outputs per employed were 2,880 tons and 2,725 tons. Although it is reported that mechanisation of loading of minerals at the working face continued, but at a greatly reduced rate, it is reasonable to assume that the improving outputs were mainly due to the increasing use of mechanical appliances; they would not show their full effect until workpeople had had time to familiarise themselves with their use.

The number of fatal accidents, connected with haulage and transport was 14 compared with 20 in 1952. It is reported that in seven separate cases, drivers of trackless vehicles lost their lives when their machines overturned on access roads or the edges of waste tips and it is added that—"in three of these cases it is questionable if the drivers were as competent as they should have been." An early passage in the report may have some bearing on this. It is stated that although there has been difficulty in obtaining men experienced in rock work and plant maintenance, there is "no shortage of applicants to drive the many types of transport vehicles now widely employed at quarries." This would seem to indicate that driving a mechanical vehicle is an attractive job and that men with a driving licence, at times assume that because they have experience of driving a lorry on the road, they are competent to manage a bull-dozer or a trackless vehicle on rough access roads with steep gradients and sharp bends, or to take part in tipping operations on waste banks.

In the various classes into which accidents are divided in the report, falls of ground appears as the second most serious cause of fatal accidents, eleven in 1953 compared with eight in 1952. Although an unexpected sudden fall of ground from a quarry working face might be considered to be the cause of entirely fortuitous accidents, in the whole of the various cases of which particulars are given in the report, comments are added suggesting that more care and foresight would probably have eliminated most of them. In connection with such falls favourable mention is made of a drifter drill which can be controlled pneumatically at distances up to 45 ft. from the working face.

Fatal accidents and cases of reportable injury connected with the use of explosives were 2 and 8 in 1953, showing a great improvement over the figures of 18 and 28 of 1952. None the less it is remarked that there is no doubt but that a "further decrease could be achieved if explosives were used with a little more respect and the usual precautions always observed." The use of electricity resulted in three fatal accidents. Two were due to the jibs of excavators coming into contact with overhead lines. This type of accident is by no means confined to quarries. The Ministry of Fuel and Power Safety Circular No. 183 which deals with this matter, should be in the hands of anyone concerned with outdoor excavation or constructional work.

* * *

* *Report of H.M. Inspectors of Mines and Quarries under the Metalliferous Mines Regulation Act*, 1872 *and the Quarries Act*, 1894, *for the year* 1953. H.M. Stationery Office (2*s.* net.)

MEDIUM SIZE OIL-FIRED BOILERS

A range of oil-fired boilers has recently been produced by the Gas Division of Thomas de la Rue and Company, Limited, 20–30 Buckhold-road, London, S.W.18, for central heating and direct hot water supply. The outputs of the boilers initially available are from 108,000 to 216,000 B.Th.U. per hour, and it is hoped to extend the capacity upwards in the near future. The boilers are automatically controlled; when switched on the ignition starts and after a time delay the fan and oil pump motors are switched in. If the ignition fails, then the fan and pump will not start, and if there is a fault in the oil supply and the mixture is too weak to light, the Danfoss control box in the flue operates. This control box cuts out the main supply if there has been no temperature change in the flue gases, thus ensuring positive safety control. If the flame fails during operation the control box will again cut the main supply out; this time, however, it will cut in again automatically after 4 or 5 minutes. Should the fault have been intermittent the boiler will continue to operate satisfactorily, but if the fault is permanent, the boiler will not restart. Efficiency of these boilers is claimed to be about 78 per cent.

HYDRO-ELECTRIC POWER IN THE AUSTRIAN TYROL

An important Austrian water-power development scheme being carried out by the Tauernkraftwerke Aktiengesellschaft is nearing completion. This company derives its name from the Tauern mountain range which is situated some 17 miles south of Zell am See. The Grossglockner is the dominating peak of this range and the development to which reference is being made is known as the Glockner-Kaprun scheme. It is concerned with the utilisation of the waters of the Kapruner Ache, the river flowing almost due north down to Kaprun Valley and joining the Salzach River, a tributary of the River Inn, which is, in turn, a tributary of the Danube. Kaprun, a small village at the head of the valley, is the site of the main power station.

The development has been carried out in two stages, described respectively as the main stage and the upper stage. Their extent is indicated in the profile and its accompanying map. Preliminary work on the main stage was begun as long ago as the year 1939, Professor Grengg of the Institute of Technology at Graz having prepared a description of the whole project before the Second World War. Little could be done until after the termination of hostilities and it was not until 1948 that, largely with the aid of Marshall Plan funds, work could be started on a serious scale. The main stage covered the formation of the Wasserfallboden reservoir by the construction of the Limberg dam, and the Kaprun power station with the connecting pressure tunnel. The Limberg dam was completed early in 1951, but it was possible to store water at a usable level in 1949 and the Kaprun power station went into operation in that year. The dam is shown in the photograph.

The upper stage, now approaching completion, covers the formation of the Mooserboden reservoir, by building the Mooser and Drossen dams, the driving of a pressure tunnel; and the installation of penstocks to serve a second power station at the Limberg dam. A feature of the upper stage is the diversion of the waters of the Möll river and its tributary the Leiter rivulet, into a reservoir at Margaritze. A tunnel connects the Margaritze reservoir with the Mooserboden reservoir, but the maximum water level of the former is below that of the latter. Accordingly a pumping station is being built at the Mooserboden end of the tunnel to deliver the Möll river water at the necessary higher level. If the level of the Mooserboden reservoir falls below that of the Margaritze reservoir pumping will not be necessary and the Möll river waters will flow naturally into the Mooserboden.

Taking the scheme as a whole, a head of water of 1,239 m. is utilised in two stages, the two generating stations having a combined capacity of 332,000 kW, producing 615 million kWh per annum, 76 per cent. of which is in the winter months. When the pumped storage is operating the output will be raised by 200 million kWh to 815 million kWh. The whole of this development is accommodated within a relatively small area, the bee-line from the first water intake to the last turbine discharge being only 26·5 km. long. The waters of the Kapruner Ache, the main river, are reinforced by various tributary streams; the positions of these are indicated on the profile. The discharge points of the Mooserboden and Wasserfallboden reservoirs are 2,000 and 1,500 m. above sea level.

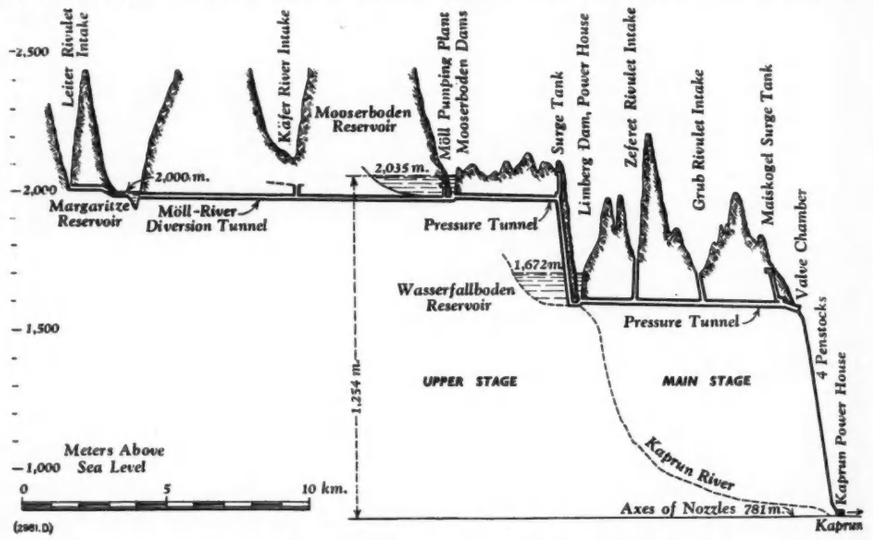
The Wasserfallboden reservoir has a capacity of 86 million cub. m., a maximum head water level at 1,672 m. and a minimum level at 1,590 m. The Limberg arch dam is 120 m. high, with a crest length of 350 m. and an average width of 6 m. at the crest. It incorporates 446,000 tons of concrete. The pressure tunnel carrying the water to the head of the power-station penstocks is 7 km. long, laid on a 0·26 per cent. gradient and with an internal diameter varying from 3·20 to 3·34 m. The waters of the Zeferet and Grub rivulets join the tunnel at distances of 1,750 and 4,097 km. from its upper end. At Maiskogel, at the penstock end, there is a surge chamber, and beyond this an armoured shaft 576 m. long and laid on a gradient of 18·7 per cent. This shaft terminates in a valve chamber at the head of four penstocks, each having a length of 1,200 m. and an inside diameter varying from 1·40 to 1·15 m.

The Kaprun power station is equipped with two 64,000-h.p. horizontal-type Pelton wheels driving 45,000-kW three-phase alternators, and two 83,000 h.p. similar sets driving 55,000-kW alternators. All the sets run at 500 r.p.m. and generate at 10 kV. The 64,000-h.p. units have two single-nozzle Pelton wheels and the 83,000-h.p. units two double-nozzle Pelton wheels. The station also contains two 50,000-kVA and two 70,000-kVA transformers. These step up from 10 kV to 110 kV and feed an outdoor switching station, situated in the neighbourhood of the power station and with lines radiating to Vienna and the Tyrol.

The Mooserboden reservoir has a capacity of 86 million cub. m., like that of the Wasserfallboden. The maximum water level is at 2,035 m. and the minimum at 1,960 m. The two dams forming the reservoir are approximately 100 m. high and embody some 1,000,000 cub. m. of concrete. A pressure tunnel 4·5 km. long and varying in inside diameter from 3·30 to 3·20 m. conducts the water to the head of an armoured pressure shaft 670 m. long, with an inside diameter varying from 2·50 to 2·90 m. This leads to the Limberg power house situated at the base of the Limberg dam. The pressure tunnel is provided with a surge tank at the pressure shaft end. The Limberg station is being equipped with two 85,000-h.p. Francis turbines, running at 500 r.p.m. and driving 62,000-kVA three-phase alternators generating at 10 kV. The station will also contain two 63,000-kVA transformers.

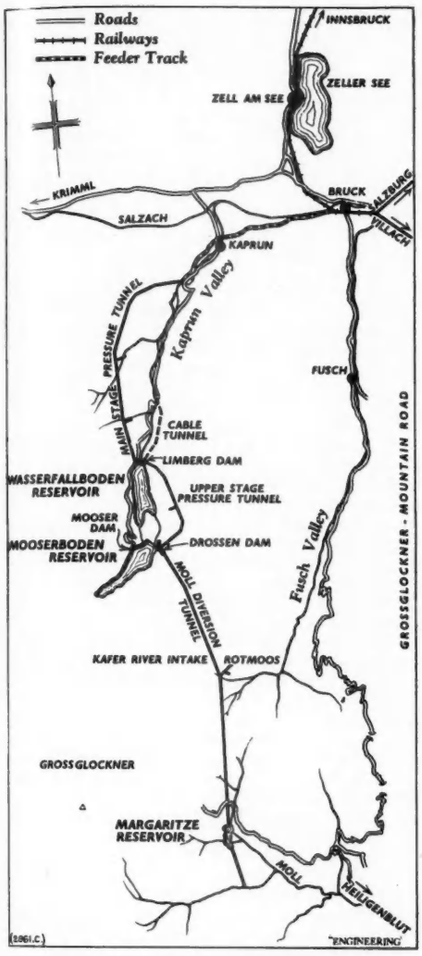
The Limberg power house is also equipped with two 75,000-h.p. storage pumps arranged so that they may be driven by the turbine sets. These may be brought into use at times of light load on the station and used to lift water from the Wasserfallboden reservoir to a higher storage level in the Mooserboden reservoir. The station also contains two 12,500-kVA 10/110 kV transformers connected to the 110-kV system for supplying the pumps in the Möll pumping station.

The Margaritze reservoir, trapping the waters of the Möll river, has a storage capacity of 4 million cub. m., a maximum water level at 2,000 m. and a minimum at 1,980 m. The Leiter rivulet is diverted into the reservoir through a non-pressure tunnel. Two dams had to be built to form the reservoir. The first, the Möll dam, is of the arch type 58 m. high with a length of crest of 170 m. The thickness at the crown is 3 m. and at the base 7·5 m. It contains 35,000 cub. m. of concrete. The second, the



Profile of the scheme, showing the upper stage (now nearly completed) and the main stage.

The Limberg dam, shown under construction, forms part of the main stage of the Glockner-Kaprun hydro-electric scheme in the Austrian Tyrol.



Map of the Glockner-Kaprun scheme.

Margaritze, is a gravity dam 40 m. high and with a crest length of 172 m. It embodies 33,000 cub. m. of concrete. The Möll river diversion tunnel connecting the Margaritze and Mooserboden reservoirs is 11·6 km long and varies in diameter from 2·9 to 3·4 m. The waters of the Käfer river are diverted into it about half way along it. The tunnel has an average gradient of 0·34 per cent. and the maximum rate of water flow is 20 cub. m. per second. When the water level of the Mooserboden reservoir is below that of the Margaritze reservoir, water flows by gravity to the former from the latter. When water has to be lifted from the maximum level of the Margaritze reservoir to fill the Mooserboden reservoir to a higher level, the pumping plant at the lower end of the tunnel is brought into use.

The underground pumping station contains two single-stage centrifugal pumps driven by 6,700-kW asynchronous motors, the maximum delivery capacity of the installation being 20 cub. m. per second. The water flowing down the diversion tunnel may, if desired, be diverted directly to the penstocks of the Limberg power station instead of being supplied to the Mooserboden reservoir. If this reservoir is full, water from Margaritze may also be conducted to a surface canal leading to the Wasserfallboden reservoir.

The scheme has included the building of an auxiliary power plant comprising two 330-kVA generating units supplied from a daily pondage reservoir of 200,000 cub. m. capacity. Of the total output of 615 million kWh per annum of the whole installation, 465 million will be generated by the main stage and 150 million by the upper stage; one cubic metre of water will produce 1·95 kWh in the main stage and 0·79 kWh in the upper stage.

PERFORMANCE TESTS ON INDENTORS FOR ROCKWELL HARDNESS TESTING*

By R. S. Marriner

To establish a standard of hardness using the Rockwell principle it is necessary to know to what extent hardness values are affected by the choice of indentor. Direct comparison of a few results from different indentors can be misleading as the local variations of the test blocks used and variability of the testing machine affect such comparisons. Details of a method of eliminating these sources of variability from the results are given and some additional sources of performance difference, such as the orientation of the crystallographic axes of the diamonds, are discussed.

FORM OF INDENTOR

In the measurement of hardness by indentation it has always been appreciated that truth of form of the indentor is a basic requirement, and this is recognised in the stringent specification given in the British Standard B.S. 891 : 1940 for the diamond indentor prescribed for tests using the Rockwell principle. The manufacture of indentors to the British Standard is not easy and experience at the National Physical Laboratory indicates that few indentors satisfy all the tolerances laid down. In addition, measurements made at the Laboratory have established the presence of an error of form which is not covered in the Standard, and which is likely to influence the performance of an indentor. It is, therefore, not surprising to find in the literature references to the variability introduced by the use of different indentors.

In current industrial operations it frequently happens that a very rigid specification of hardness is laid down and difficulties are encountered in maintaining an adequate standard of hardness. At present, the only practicable scheme for ensuring a uniform standard of hardness throughout industry appears to be the use of calibrated test blocks, but this translates the onus to those responsible for supplying the blocks or to those organisations which undertake their calibration. It is obviously desirable that such organisations should be in agreement not only nationally, but also internationally, and it is unfortunate that, at the international level, the agreement is at present not satisfactory. In seeking the causes for the discrepancies which exist, particularly among those institutions which possess dead-weight hardness testing machines, it quickly becomes evident that differences in the indentors used may be a prime factor.

Experience at the National Physical Laboratory in the calibration of hardness test blocks by means of a dead-weight testing machine has shown very clearly how important is the form of the indentor: differences in performance were found even with indentors conforming very closely to the British Standard. To establish an irreproachable standard of hardness, it clearly became necessary to determine to what extent reproducibility of the standard is limited by the choice of indentor used for making the indentations and the present paper describes some preliminary work which has been carried out at the Laboratory with this object in view.

Investigation of the differing performance of indentors can be resolved into three stages:

1. Precise measurement of hardness values given by each of a group of indentors at various levels of hardness.

2. Determination of the precise geometric and structural differences between the indentors used.

3. Correlation of 1 and 2 to achieve a specification which would result in the production of indentors for calibration work whose performance could be predicted.

Stage 3 can only follow from 1 and 2, but so far little work has been done on the differences in structure of the diamonds used in indentors or the precise orientation of their crystallographic axes which, as will be seen later, may affect their performance. However, the work carried out at the National Physical Laboratory by Tolmon, Wood and Hall† on the measurement of the form of indentors by interferometry has made it possible to group indentors into those having no appreciable departures from the ideal geometric form and those having larger but known departures.

As regards 1 above, the measurement of the difference in performance of two indentors is hampered by the fact that two indentations on a test block cannot be made at the same time and at the same spot on the block. In practice, at some stage of the comparison the indentors must be interchanged in the machine and the indentations must be made at different points on the test block. Hence observed differences in hardness number cannot be attributed to the indentors alone since they will be influenced by the random variations due to indentor mounting, the performance of the machine, and local variations in hardness of the test block.

To obtain a precise estimate of the effect due to differences in the indentors, it is necessary to make the effects due to test block and machine as small as possible in comparison with that due to the indentor and, further, to ensure that any systematic effects are common to the different indentors. This problem of isolating one source of variation from other variations has been solved in many ways in other fields and one solution, that of the Greco-Latin square design of experiment, lends itself admirably to the problem of hardness testing. Using a dead-weight Rockwell hardness machine this design of experiment has been used to determine the performance difference between seven indentors at six levels of hardness and to measure systematic effects such as the lubrication of the test block, method of mounting, etc. Details of the design and analysis of the results of these experiments are discussed in this article.

INDENTORS USED IN EXPERIMENTS

For the principal tests seven indentors obtained from three different manufacturers were used. Designating letters and relevant data concerning these indentors are given in Table I.

No precise information about the source of the diamonds used in these indentors was available although it was known that fundamental differences existed because their appearance under ultra-violet light varied. Indentor A fluoresced red while the others either fluoresced bluish green or did not fluoresce.

The marked differences in form of the cones suggested that the cone axes were differently related to the diamond structure and accordingly X-ray photographs were made of five of the indentors. These showed that the tri-lobed indentors had their cone axes nearer to an axis of three-fold symmetry (111) than to any other axis. Fig. 1 shows diagrammatically the projection of the crystallographic axes on a plane perpendicular to the axis of the cone together with the measured out-of-roundness of the cone. It will be seen from Fig. 1 that the lobes of the tri-lobed sections correspond with the direction of the projected (100) axes. (The indentors X and Y, which had been borrowed from abroad for the hardness measurements, were not available for the X-ray examination.)

The six test blocks used covered the range H_RC (Rockwell hardness number, Scale C) 28 to H_RC 67, and the results of six random indenta-

* Communication from the National Physical Laboratory. Abridged.

† "Precision Measurement of Rockwell Hardness Diamond Penetrators," Tolmon, F. R. and Wood, Jill G.; ENGINEERING, vol. 172, page 89 (1951).

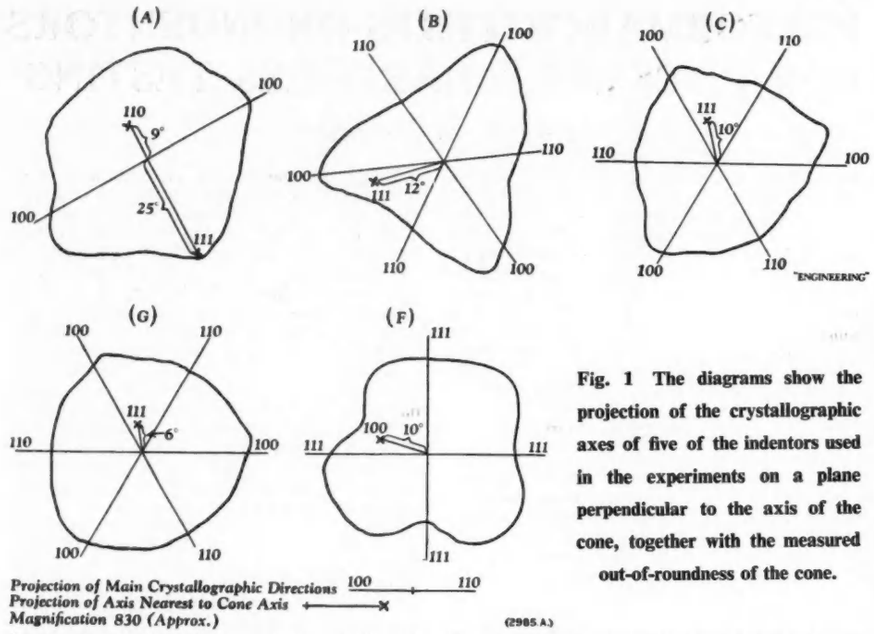


Fig. 1 The diagrams show the projection of the crystallographic axes of five of the indentors used in the experiments on a plane perpendicular to the axis of the cone, together with the measured out-of-roundness of the cone.

tions made on each by the manufacturer indicated that they were uniform in hardness to H_RC 0·2 for the hard blocks and to H_RC 0·5 for the soft blocks.

ARRANGEMENT OF INDENTATIONS: THE GRECO-LATIN SQUARE

The arrangement of the indentations was dictated by the possible sources of systematic error which would affect the comparison of the indentors. These sources of systematic error are as follows:—

(i) In a run of a large number of indentations there might be a small but systematic drift in the performance of the machine.

(ii) After clamping an indentor in the machine the first few indentations are often unreliable as the indentor appears to "seat itself" under load. Hence a systematic error which can be assigned to the order of indentation may be introduced.

(iii) A possible non-uniformity of hardness of the test block which might take the form of certain bands in the surface being harder or softer than other bands. Such a condition could arise through a failure to quench and temper uniformly.

In addition to these sources of systematic error, random errors arise from local variations in hardness of the test blocks and small variations in the performance of the machine while loading. To minimise or isolate these sources of error the following scheme was adopted.

Consider one of the test blocks. Each of the seven indentors was used in turn to make seven indentations on it. The 49 indentations so made were arranged in seven rows and seven columns (compare Table II), the rows and columns being spaced 0·2 in. apart. The positions of the seven indentations produced by any one indentor were so arranged that one occurred in each row and one in each column. In addition, it was arranged that of the seven first test indentations made after mounting each indentor, one occurred in each row and column. The seven second test indentations were disposed similarly, and so on. (It should be noted, however, that in all cases three dummy indentations were made near the edge of the block immediately following a change of indentor. These indentations were not part of the Greco-Latin Square.)

A typical arrangement is shown in Table II where the letters designate the indentors, the numbers the order of indentation, and the rows and columns the corresponding positions on the test block. Such an arrangement is known as a Greco-Latin Square.

All 49 indentations were made on one block before going to the next, and the order in which the indentors were used was randomised and different for each block.

The consequence of this arrangement is that, for each block, the mean of the results in any column comprises a result from (*a*) each indentor, (*b*) each order of indentation, (*c*) each row, and hence comparison of column means is unaffected by any systematic error arising from indentor, order of indentation, or row. Similarly, the mean of the results from any one indentor is independent of systematic errors from the three other sources and an unbiased comparison of indentor effect can be made.

TABLE I

Manufacturer	Identification of indentor	Departure of angle from nominal	Daparture of spherical tip from nominal form	Surface finish	Circularity of cone		Displacement of cone axis from nearest crystallographic axis
					Departure from circle	Form	
		Minutes	In.		In.		
1	A	+ 4	Nominal within ± 0·000 05	Very good	0·0005	4-lobed	9 deg. from (110)
1	B	− 2½	,,	,,	0·0008	3-lobed	12 deg. from (111)
1	C	− 7	,,	,,	0·0005	3-lobed	10 deg. from (111)
1	G	—15	,,	,,	0·0003	3-lobed	6 deg. from (111)
2	F	+ 7 to +14	0·0001 excess	,,	0·0006	4-lobed	10½ deg. from (100)
3	X	+21 to +26	Nominal within ± 0·000 05	Poor	0·0004	4-lobed	—
3	Y	+17 to +24	0·0001 excess	,,	0·0004	Elliptic	—

Notes.—1. The nominal cone angle and radius of the spherical tip for these indentors, as given in B.S.891 : 1940, are 120 deg. and 0·2 mm. (0·008 in.), respectively.
2. The departure from circularity, column 6, is defined as the difference in diameter of two imaginary co-planar concentric circles such that the annular space between them would just contain the profile of the surface under test.
3. Examination of interferograms of these indentors showed that the tip of indentor F was sharp and wedge shaped and the blend of the spherical tip with the cone was poor in comparison with the other indentors.

TABLE II

Row	Column						
	1	2	3	4	5	6	7
1	G2	B3	C6	Y5	F1	A7	X4
2	F4	X7	G5	A3	C2	Y1	B6
3	C7	Y6	F2	B4	G3	X5	A1
4	A6	G1	X3	F7	Y4	B2	C5
5	B5	A2	Y7	C1	X6	G4	F3
6	X1	F5	A4	G6	B7	C3	Y2
7	Y3	C4	B1	X2	A5	F6	G7

RESULTS OF EXPERIMENT

To present the indentor effect clearly the hardness number for each plate was assessed as the grand mean of all 49 indentations. This grand mean was then subtracted from the mean value for each indentor and the resulting departures were plotted against the average for each plate as shown in Fig. 2. It will be seen at once that :

(1) Indentor F is an outsider in that its performance does not agree with the other indentors at low levels of hardness. Reference to the note at the foot of Table I shows that its tip is sharp and inferior as regards form to the others. A sight of the interferogram of the tip is uncompromising in its rejection of this indentor.

(2) The performance of indentors C and G differs markedly from that of X and Y; the former give departures which are positively correlated with hardness while the latter are negatively correlated (i.e., the slope of the plots for C and G are different in sign from those for X and Y). Reference to Table I reveals three differences between these indentors, viz., manufacturer, cone angle, and surface finish, and any one of these may account for the observed difference in performance. The manufacture of the indentor may affect its performance by the particular methods used for cutting and fixing the diamond in its mount and by the particular orientation of the crystallographic axes.

(3) Indentors A and B, although made by the same manufacturer as C and G, behave quite differently, but reference to Fig. 1 shows that indentor B is markedly tri-lobed and this feature may directly account for its increased penetration.

Complete correlation between the results given in Fig. 2 and the factors displayed in Table I is not possible at this stage as the indentors used have insufficient factors in common.

ANALYSIS OF RESULTS

Before discussing further experiments, it will be useful to consider what additional information can be obtained from the Greco-Latin design. As stated above, before the observed performance differences can be regarded as real, it is important that these differences must be large in comparison with the random variations in hardness value introduced by local variations in the test block and possible irregularities in performance of the dead-weight machine. If this is not so, a repeated trial might show that the apparent difference between two indentors has disappeared or even reversed. The method of demonstrating that the observed differences are real and that test block and machine variability is negligible is as follows.

Each of the 49 hardness values for each block may be regarded as composed of the sum of

(1) The true average value of the block.

(2) An effect due to the particular indentor used.

(3) An effect due to the order of indentation (i.e., whether it was the 1st, 2nd or 3rd, etc., indentation).

(4) An effect due to the particular row in which the indentation lies being harder or softer than average.

(5) A similar effect due to the column in which it lies.

(6) A random effect due to a local variation in hardness of the block together with any random variation in the performance of the machine caused by ambient temperature change, external vibration, etc.

The total variation, or more precisely the

variance, of the 49 observations is obtained from the sum of the squares of the departure of each observation from the grand mean. This total variance can then be broken down into the variance which arises from each of the effects detailed in (2) to (5) above and a residual variance due to the random effects of local irregularities of hardness of the block and vagaries of the machine's performance.

The ratios of the variances due to (2), (3), (4) and (5) to the residual variance (called F ratios) are compared with standard tables to ascertain whether the indentor, order, row, and column effects, respectively, are real, i.e., sufficiently large in comparison with the random effects to exclude the possibility that they have occurred by chance. In the experiment described above the indentor variance was, for all test blocks, extremely high in comparison with the residual variance and the order, row and column effects negligible.

Having removed the variance due to indentors, orders, rows and columns from the total variance the residual variance can be used for two purposes. In the first place it gives a measure of the accuracy of the results for each indentor. For the experiment described it shows that the results plotted in Fig. 1 may be relied on to $\pm H_RC\ 0{\cdot}15$ with 95 per cent. confidence, i.e., one in twenty of the results plotted may be in error by as much as $H_RC\ 0{\cdot}15$ but the majority will be well within this value.

In the second place, it gives a measure of the reliability of the experiment as a whole. For example if, for one of the six test blocks used, a residual variance was obtained many times greater than for the other five, the uniformity of hardness of the block or the performance of the machine while indenting that block would be suspected even if the results for the indentors appeared to conform with the results for the other blocks. This use of the residual variance as a measure of the precision of an experiment led to two further experiments.

MOUNTING THE INDENTOR AND APPLYING THE LOAD

The first experiment was designed to determine the effect of different methods of mounting the indentor in the dead-weight machine and different methods of applying the load.

To achieve this, six Greco-Latin Square arrangements were superimposed on one test block, i.e., each indentation of each square was displaced a small distance from each indentation of the previous square. The indentations comprising a square were made under different conditions of mounting the indentor and operating the machine.

From the results of each square was obtained an average value for the hardness of the test block and a residual variance, as shown in Table III.

The results in Table III show that hardness value and residual variance are highly correlated. Further, it is known that the conditions of working when the low residuals were obtained were superior to those resulting in high residuals. The smooth action of a hydraulic lift for changing the load as compared with a mechanical lift reduced the residual variance; similarly, clamping the indentor in a direction co-axial with the axis of the cone by a draw screw threaded into the end of the shank as compared with clamping the indentor by a side set screw also reduced the residual variance and increased the value of hardness obtained. It is interesting to note that these results confirm the general impression among observers that in a set of observations higher values are the more reliable while low values indicate that the machine is not giving of its best.

TABLE III

Method of Moving Load	Method of Mounting Indentor	Mean Hardness Value	Residual Variance
		(H_RC Units)	(H_RC Units)
Hydraulic	Co-axial draw screw	64·69	0·018
,,	Loose in an adaptor which was rigidly held by a draw screw	64·57	0·023
,,	Co-axial draw screw	64·70	0·031
Mechanical	Co-axial draw screw	64·16	0·050
,,	Co-axial draw screw	64·27	0·064
Hydraulic	Held in the adaptor by a side set screw	63·24	0·077

THE EFFECT OF GREASE: USE OF DIFFERENT MACHINES

The second was a double experiment carried out (*a*) to determine the effect of grease on the test block, and (*b*) to compare the performance of a dead-weight standard machine with a commercial machine employing a lever system.

Two sets of indentations were made on a test block using the dead-weight machine in the manner described above. The first set was made with the block clean and dry and the second with the block smeared with Vaseline. A third superimposed set was made using a lever-system machine with the same indentors and the test block clean. The whole experiment was repeated with a second test block of different hardness.

The results were as follows. The mean hardness difference between the indentations made on the clean dry block as compared with the greased block were $H_RC + 0{\cdot}03$ and $H_RC - 0{\cdot}01$ for the two test blocks. Neither of these differences is significant with regard to the residual variance and it is concluded that grease on the surface of the test block does not affect the hardness value obtained.

A direct comparison of the residual variances from the two machines showed that results from the dead-weight machine were twice as reliable as those from the other machine. In fact, if the appreciable variance due to local variation in hardness of the test blocks were known and was removed from the residual variances then the accuracy of the dead-weight machine would appear even higher in comparison with the other machine.

At present it is not possible to separate variation in hardness value due to the machine from that due to local variations in the test blocks. An indication that the latter is appreciable for some test blocks is that, in the analysis of variance, the row and column effect referred to above is sometimes significantly high in comparison with the residual. The fact that the average hardness along or across a standard test block can vary appreciably implies that there are probably equally large localised variations.

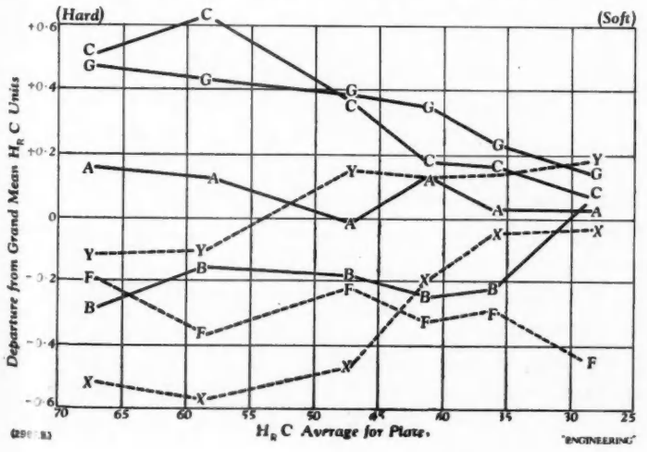


Fig. 2 The performance of seven indentors on plates of varying hardness. Each indentor was used seven times on each plate, and the hardness of the plate was taken to be the average of the forty-nine readings. The graph shows the departure of each indentor from the grand mean at different hardness levels.

CONCLUSIONS

1. The most important conclusion derived from the experiments described herein and other experiments of a similar nature carried out at the National Physical Laboratory is that the greatest source of variation in hardness values lies in the different performance of the indentors, particularly at the higher levels of hardness. Until all the causes of performance difference are isolated and controlled the level of hardness given by any machine will be dependent upon the indentor used.

2. The application of the Greco-Latin Square design of experiment to the hardness problem is a sure method of isolating the sources of variation of hardness values, and provides a means of comparing the performance of different indentors and of different machines, the consistency of performance of a single machine or the uniformity of hardness of test blocks.

3. The performance of an indentor may be influenced by any one of the following properties:

(i) geometrical form which includes radius and truth of form of the tip, cone angle, blending, and out-of-roundness of the cone;

(ii) surface roughness;

(iii) structure of the diamond, including its hardness;

(iv) orientation of the crystallographic axes to the cone axis.

(v) method of manufacture and fixing of the diamond in its mount.

The experiments carried out so far on the lines described in this paper have not indicated that any one of these properties has a paramount influence on the performance. To ascertain the relative importance of the various factors further investigations on similar lines are being pursued.

The author desires to acknowledge the comments and suggestions he received from his colleagues in the Metrology Division, National Physical Laboratory.

The work described above has been carried out as part of the research programme of the National Physical Laboratory and this paper is published by permission of the Director of the Laboratory.

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EMERGENCY BATTERIES

Operated by Contact with Water

A development initiated by the war is that of " one-shot " batteries activated by water. Once begun, the operation is continuous for the life of the battery. One use for these is for rescue flares to be thrown overboard—contact with the water immediately lighting the lamp. Batteries of several sizes have been developed by Chloride Batteries Limited, Swinton, Manchester. The smallest, weighing less than half-an-ounce complete with bulb, uses lead peroxide and magnesium electrodes; it is employed in meteorological balloons and gives a light for 45 minutes.

Larger sizes employ cuprous chloride and magnesium as the electrodes, and a 2½-oz. size will illuminate a 0·24 W bulb for 12 hours. One weighing 4 oz. will last for double this period. Both these sizes are attached to " Mae Wests ". The largest commercial size, for use with rafts and floats, will light a 2 W bulb for at least 24 hours. A unit as large as 200 ampere-hours has been produced for special purposes. All sizes can be kept indefinitely as long as they are protected from moisture.

RECTIFICATION

SOME METHODS OF PRODUCING DIRECT CURRENT

From May 31 to June 7, Brown, Boveri and Company, Limited, held a series of conventions at their works in Baden, Switzerland, the subject of which was mutations. It was many years ago that this firm produced their first mercury-arc rectifier, which was called by them a mutator, and since then several different types have been introduced, as well as the mechanical mutator, perhaps better known as the contact rectifier. The object of the recent convention was to demonstrate to visitors the latest developments in these fields and to show some actual installation of both types.

MERCURY-ARC TYPES

The mercury-arc mutator has been a familiar item of equipment for many years. A great step forward was made in its usefulness when the control grid was included which allowed a high degree of regulation to be achieved. Early single-anode types developed into multianode units with 12 or 18 anodes and these have proved specially suitable for traction work. With the latest advances in techniques, the company have now produced six-anode rectifiers which have the same capabilities as the 18-anode models but are smaller in size and simpler in construction. One of these, is shown in Fig. 1, mounted on its cooling fan. It is rated at 2 MW at 3·6 kV or 930 kW at 750 volts; there are control grids for voltage regulation and for the suppression of short circuits and back-fires. This model is not continuously evacuated but pumped models are also made.

For large installations, especially for electrolytic pressures where the voltage exceeds 400 V, the water cooled 12- and 18-anode types are being superseded by the single-anode steel-tank type with vacuum pump and water cooling, of the form shown in Fig. 2. This particular set of six single-anode tanks is rated at 5,000 amperes at 750 volts. The advantages offered by the single-anode assembly are: a reduction in size; a smaller voltage drop across the arc; easy replacement of a faulty tank; low storage costs; and the ability to use circuits with different cathode potentials, a feature of value in high-voltage installations. The single-tank type can also be arranged for air-cooling, and there are pumpless models as well.

MECHANICAL RECTIFICATION

Where low voltages are employed and the loading is comparatively steady, the contact rectifier finds its place. Although used for several years, they are not as well known as some other types. Briefly, they consist of sets of contacts which are mechanically opened and closed at such points during the cycle of the alternating current, that the final voltage is approximately constant. A diagram of the operating principle is given in Fig. 3, which also shows the resultant wave form. In practice the three phase star-connection of the transformer is usually replaced by a Graetz three-phase bridge connection or a six-phase connection with absorption reactance coil, giving a better utilisation factor, and a much smoother wave form. The sequence timing of the contacts is arranged so that they open off-load, and any remaining current is taken by so-called " commutation reactors " in series and by shunt valves in parallel with the contacts. This gives the contacts a very long life without wear. An automatic regulator, operated electronically, adjusts the contact period for each set independently. Voltage regulation is achieved by changing the phase displacement of the synchronous driving motor, and by an on-load tap-changer on the transformer.* Automatic regulation over a range from 40 to 100 per cent. of full load is possible, over which range the contacts continue to open and close under sparkless conditions.

Contact rectifiers are capable of handling very large currents, 25,000 amperes or above, at voltages below 500. At 100 volts the overall efficiency is 95 per cent., increasing to 97 per cent. at 300 volts inclusive of all transformer and choke losses. The size is small, maintenance is low, and with the sound-proof cabinet contact noise is not excessive. Even on unstable supplies the tendency for back-fires is small, and should one occur, the rectifier is automatically switched out, and only has to be switched in again to restore the original state. A contact life of 4,000 hours is the average. A unit complete with cooling fan and rated for 5 MW at 200 volts is shown in Fig. 4.

* *Brown Boveri Review*, vol. 37, No. 12, 1950

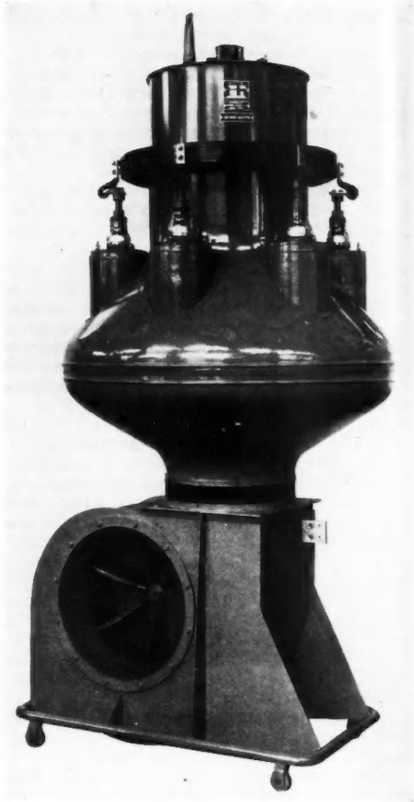

Fig. 1 Six-anode pumpless air-cooled rectifier for 2 MW at 3·6 kV. This type is replacing the 12- and 18-anode models now in use.

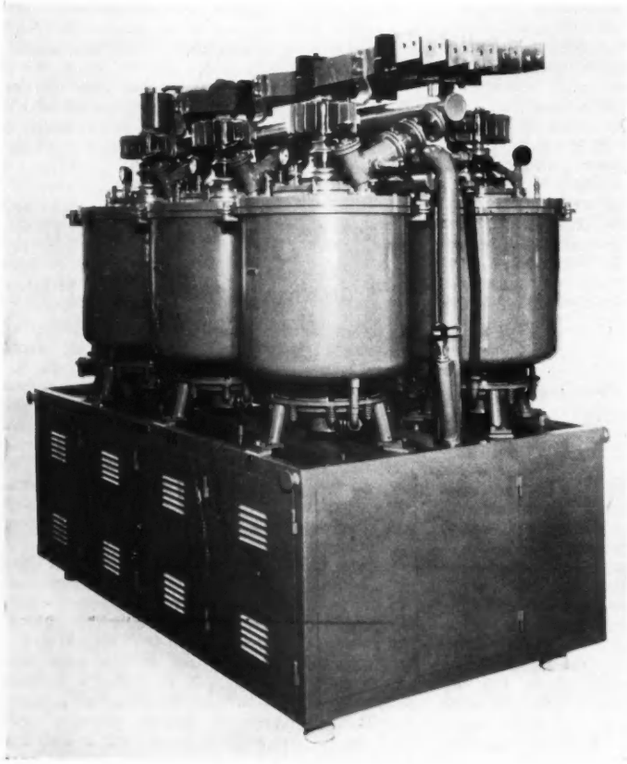

Fig. 2 Certain advantages are gained by using a group of single-anode rectifiers. Pumped and water cooled, this group of six is rated at 5,000 amperes at 750 volts.

TYPE CAPABILITIES

A series of demonstrations was arranged at the works to show the capabilities of the various types of mutator and their behaviour under various conditions. The first was performed on an air-cooled pumpless type, KLgg36, which is rated at 1,250 amperes at 750 volts. The elimination, by the addition of an inert gas before sealing, of low temperature switching surges was shown, the rectifier being housed in a cold chamber at 0 deg. C. and set to full load at 600 volts. The arc voltage as monitored by a cathode-ray tube showed very little variation.

A good rectifier for traction purposes should have a large overload capacity; be able to operate under varying ambient conditions and should be well able to extinguish short circuits under all operation conditions. A six-anode pumped rectifier, LPgg56, was used for these demonstrations. The normal rating for this size is 2,500 amperes at 750 volts, or 1,100 amperes at 3,600 volts. Air cooling was used, there being a variable-speed fan controlled by a thermostat on the rectifier casing. The surface temperature was held by this means at 55 deg. C. over all normal loads, from zero upwards, and up to an overload of 3,000 amperes at 1,300 volts, which was held for three minutes. The fan speed varied from 380 r.p.m. at no load to 800 r.p.m. at this overload. Demonstrations were given of short circuit extinction, both at full load and overload, using the grid protection,

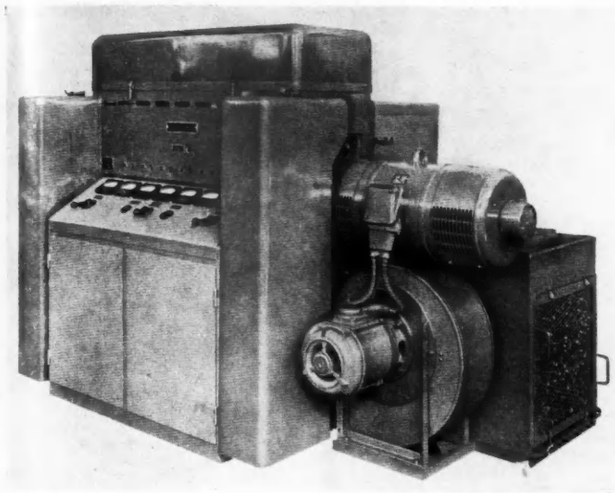

Fig. 4 Contact rectifiers are particularly suitable for steady loads at low voltages. This model has built-in air cooling and is rated at 5 MW at voltages between 200 and 500.

and also of circuit interruption using a rapid-acting direct-current circuit-breaker.

The capabilities of a single-anode group were demonstrated on a unit of six rectifiers of type WPgg91. These are water-cooled and vacuum-pumped and are rated at 5,000 amperes at 750 volts. The high level of control, and the connection between the anode blocking ability and the grid control were shown by means of experiments indicating the likelihood of arc-backs; the effect on this of reduction of the working temperature; and the operation of the group in parallel with a type LPgg56. In this last test, an arc-back was induced in the latter, but was resisted by the WPgg91 group.

As an example of mechanical rectification, the contact rectifier type GR6 was chosen, using Graetz connection. To this, full load (10,000 amperes) was applied immediately after starting, without any difficulty. The accurate current regulation obtainable was shown by rapidly varying the load, and also the cut-out time

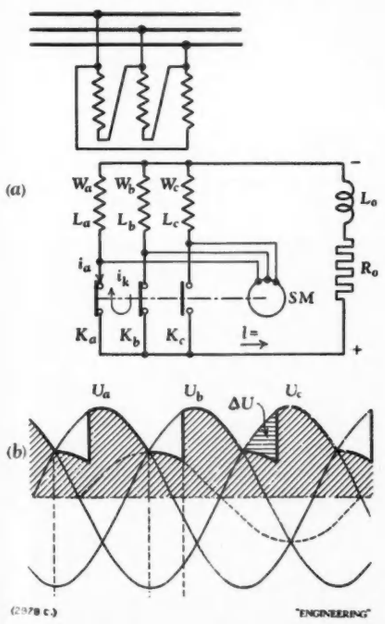

Fig. 3 Diagram showing the operating principle of the contact rectifier and the wave form produced. SM is a synchronous motor, W and L the secondary windings and their leakage inductances. L_o and R_o represent the load impedance, and K_a, K_b and K_c the contacts. In the graph U_a, U_b and U_c are the phase voltage of the transformer. ΔU is the inductive voltage drop during overlap.

regulation. A short-circuit tube was removed and replaced without shutting down, and finally, after short-circuit tests, an arc-back was induced, the rectifier shut down and a contact changed. From the moment of shut-down to the complete restoration of conditions took 3½ minutes only.

ACCURACY AND FLEXIBILITY

The second series of demonstrations was arranged to show some applications of mutators and the degree of control possible when using electronic equipment. First, in order to show how a rectifier stands up to shocks of the kind encountered in a locomotive, a single-anode type Lgg (air-cooled and pumpless) was mounted on a vibration table. The latter was operated to give horizontal accelerations of about 10 metres per second per second, while the rectifier was supplying its full load of 200 amperes.

In many rolling mills, the direction has to be reversible and an arrangement for doing this was shown next. A grid-controlled rectifier fed the rotor of the driving motor which had the field fed from a high-speed exciter. Electronic switching reversed the field supply, allowing a wide controllable range of reversal time. That is, the motor could be made to lose speed slowly, come to rest and then slowly gain speed in the opposite direction, or to come to an almost immediate stop and speed up very quickly as desired. Operation could be either by a hand-wheel, which controlled the final speed but not the rate of change, or by a series of push-buttons which allowed a set programme to be carried out. Each button was connected with a speed control which could be separately adjusted to suit the operation involved. Such a system would lend itself to completely automatic control.

In contrast to the variable speeds required with a reversing mill, a strip mill has to run at constant speed independently of the load imposed on it. For this demonstration, a direct-current motor was solidly coupled to a generator which could be loaded as required. The motor was supplied from a grid-controlled rectifier and a sensitive tachometer was attached to the shaft. From this a feed was taken to the electronic unit which in turn governed the rectifier grid and the field supply to the motor. A stroboscope was used to show any change of speed of the shaft. Load was applied to the generator in various ways but no change of speed could be observed even when 600 amperes was switched directly on or off.

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Owing to a misunderstanding it was stated in our article on page 773 of our issue of June 17 on the "Deposition of Hard-Facing Alloys in Powder Form" that the three originators of the T.L.B. process are American. We now learn that they are British but that the process is operated in the United States under licence.

EXTRA-NARROW FORK LIFT TRUCK

Handling Awkward Loads in Confined Spaces

A battery-powered extra-narrow fork lift truck, incorporating a Matling power unit, has recently been developed by Matling, Limited, 28 Caxton-street, London, S.W.1. Being only 24 in. in width and 60 in. in length (excluding forks), it can handle loads in very confined spaces and manoeuvre them round narrow intersecting gangways. The makers consider their truck to be particularly suitable for use in conjunction with the block storage system.

Control and steering is by means of a "dead-man" tiller arm, and, as the complete power unit can be rotated through 360 deg., ride-on or pedestrian control may be employed as required. Both lifting and tilting are effected hydraulically. The lifting capacity is 1,000 lb. at 18-in. load centre to a height of 10 ft., or alternatively, 2,000 lb. at 18-in. load centre to a height of 7 ft. 6 in. The masts are telescopic and the tilting range is 2 deg. forwards and 10 deg. backwards. Fixed masts can be fitted when necessary. Standard forks are 4 in. wide and adjustable, but special forks can be made, with length and design in accordance with operational requirements, to simplify the handling of awkwardly shaped goods.

Transmission from a 24-V constant-speed motor is effected through a heavy-duty single-plate clutch and a gearbox which has one reverse and three forward speeds. A separate 24-V motor operates the hydraulic system. The 4·2 kilowatt-hour battery employed in the truck is sufficient for an average day's work, and batteries can be changed in a few moments; alternatively, they can be charged in position overnight.

The simplicity of the truck as a mechanically-propelled vehicle, and the accessibility of its components ensures that servicing and maintenance can be carried out in general by the operator. The makers believe that this truck will prove particularly useful where storage space is limited.

A fork lift truck capable of operating in the most confined spaces has been developed by Matling, Limited. It is battery-powered, hydraulically-operated and only 24 in. wide.

25-FT. VERTICAL BORING AND TURNING MILL

LARGE CAPACITY WITH A HIGH DEGREE OF ACCURACY

A 25-ft. double-standard vertical boring and turning mill recently completed by George Richards and Company, Limited, Broadheath, near Manchester, which is illustrated herewith, is noteworthy for the degree of accuracy in its alignments, and for the features in its design which ensure that the accuracy can be maintained for a long period.

The machine, which weighs 280 tons, has a maximum swing of 25 ft. 3 in., with a maximum height under the tool-holders of 13 ft. The maximum height under the cross-slide is 13 ft. 5 in., and the down-feed of the tool-holders is 8 ft. The alignments are: table surface flat (for concavity only), to 0·002 in. on the maximum diameter; edge and face of uprights square to within 0·002 in. in 126 in.; movement of ram square with surface of table in both directions to 0·002 in. in 96 in.; cross-slide parallel with table to 0·002 in. in 11 ft. In addition to the maintenance of these limits, particular attention has been paid to ease of setting and control.

The table, which is 22 ft. in diameter, is provided with machined T-slots, and is designed to carry loads up to 90 tons. Two flat bearing tracks support the table, and the centre spindle, of cast iron, is of the adjustable taper type. In view of the heavy load, six thermocouples have been incorporated in the tracks and spindle, and the temperatures at the six points are indicated in sequence by a pyrometer built into the vertical face of the control panel adjacent to the machine. The table is driven by a 120-h.p. 3-to-1 variable-speed direct-current motor with a speed range of 300 to 900 r.p.m. The motor works in conjunction with a three-speed gearbox. Gear changing is by a triple sliding gear driven by a ¾-h.p. motor under control from push-buttons on the panel. A range of speeds from 0·33 to 9 r.p.m. is available.

Two counterbalanced vertical tool-heads are mounted on saddles on the cross-slide, each being driven by a 3-h.p. motor controlled by push-buttons from a station on the saddle. The tool-bars can be swivelled to any angle up to 30 deg. either side of the vertical position, a graduated index being provided to facilitate setting. Each head has sixteen rates of feed from 0·007 in. to 0·75 in. per revolution, the feeds being taken from gearboxes at each end of the cross-slide. The tool-heads are entirely independent in operation and can be operated simultaneously at different feed rates. This permits the appropriate rate to be selected for each tool when machining near the periphery and near the centre of large-diameter work. Squared shafts are provided on each feed box and on the saddle so that a removable cranked lever can be used for fine hand adjustment to all head movements. Graduated dials enable adjustments to be made to within 0·001 in.

Rapid power traverse, driven by a 7½-h.p. motor, is fitted to each head, and there is automatic interlocking of the automatic feed clutch and power traverse so that the two cannot be engaged together. Large handwheels are provided on each head for rapid vertical hand feed.

DIAL INDICATION OF ELEVATING-SCREW WEAR

The cross-slide is elevated by a 22½-h.p. motor mounted on the top of the cross-girth, which drives through a cross-shaft, worms and worm-wheels to the elevating screws in the uprights. The thrust is taken on heavy roller bearings. Each elevating screw is equipped with a built-in micro-dial gauge to indicate thread wear, and by this means it is possible to maintain the horizontal alignment of the cross-slide indefinitely. Two 2-h.p. motors provide the locking power, and these motors are interlocked with the main drive motor and elevating motor to prevent accidental operation of the drive or elevation while the locking gear is incorrectly set. A vertically-adjustable measuring block is mounted on the right-hand upright for use as a datum point with gauge rods when setting the work.

Lubrication of all main bearings is automatic, with safeguards against damage due to oil failure. The main oil system, which is equipped with two rotary pumps driven by a 1½-h.p. motor, supplies oil to the bearings and receives it back for recirculation via two tray-switches. These tray-switches are electrically interlocked with the main motor, which cannot be started unless the trays are filled with oil. Automatic cut-off of the drive motor is effected by the tray-switches should the oil supply fail.

A control panel is located on the right-hand side of the machine for mounting the push-button controls for all the main motions, motor revolution counter, ammeter and table-track temperature indicator. The controls comprise push-buttons for controlling the main drive motor, and for elevating, stopping, lowering, locking and unlocking the cross-slide. Lights on the panel indicate whether the slide is locked or unlocked.

In addition to the main control panel, two seven-button pendant controls are suspended at opposite sides of the table. These provide for start, stop and inch on the main drive motor, and feed-on, feed-off, forward and reverse on the power traverse. An emergency stop-button is fitted at the bottom of each pendant.

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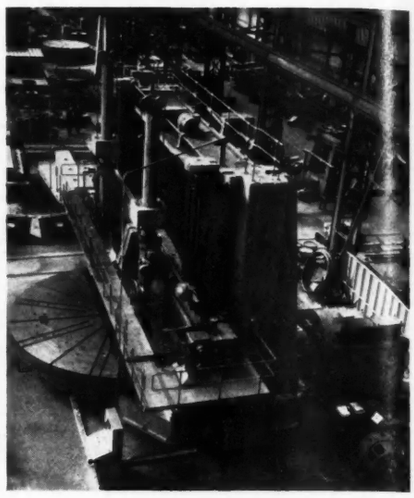
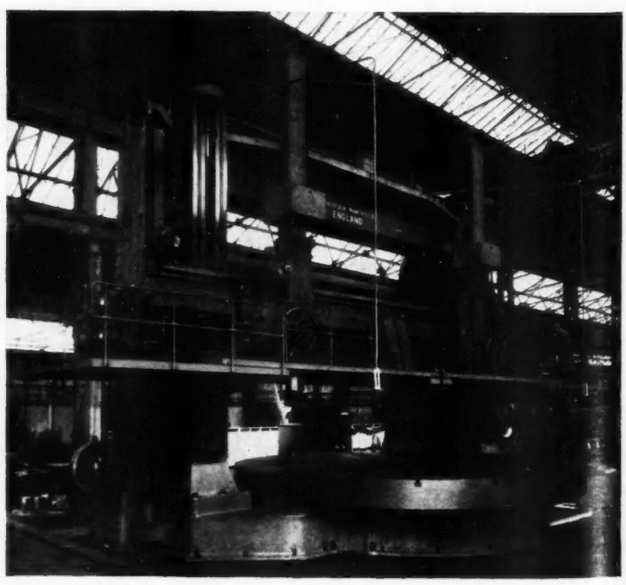
MEDIUM-SIZE FORK TRUCK

Mathew Brothers, Matbro Works, Sandy-lane North, Wallington, Surrey, have introduced a fork truck designed to fill the gap between the lighter machines of 6,000 lb. capacity and the heavy type for 10,000-12,000 lb. The new truck, type 80/12/DH, is rated for 8,000 lb. at 2 ft. centres or correspondingly for 5,500 lb. at 3 ft. 6 in. centres. It is mounted on large pneumatic-tyred wheels and has a 6-in. ground clearance. Lift height is 12 ft. at a rate of 40 ft. per minute and the pillars can be tilted 10 deg. backward and 3 deg. forward. Power is supplied by a Fordson 40 brake horse-power engine, either petrol or Diesel, and the transmission allows six forward speeds (maximum 12 m.p.h.) and two reverse.



The main drive motor, electrical control gear, cross-slide elevating motor (placed on top of the cross-girth) and one of the feed boxes are clearly visible in this view.

The control panel has all the push-buttons necessary for setting and has, in addition, a pyrometer to indicate the temperature at six points in the table-support track.



Control of the Richards 25-ft. vertical boring and turning mill is from the control panel seen on the extreme right, and from the pendant push-button stations located over the table.

ALL-WELDED ALUMINIUM-ALLOY YACHT

In ENGINEERING of August 7, 1953 (vol. 176, page 180), we described the main features of a twin-screw yacht with an all-welded hull of aluminium alloy, then under construction by Saunders-Roe (Anglesey), Limited, to the order of the British Aluminium Company, Limited. The vessel, which was designed by Laurent Giles and Partners, naval architects, of Lymington, Hampshire, is ketch-rigged and is intended primarily for sailing, but is fitted also with two Gleniffer D.B.6 engines of 72 h.p. each. She was ordered for the purpose of demonstrating the capabilities of the self-adjusting arc process of welding aluminium and its alloys in various sections and thicknesses, the equipment used being the American-made Aircomatic Mark III unit and the Argonaut Mark III, supplied by the British Oxygen Company.

When our article was written the vessel had not yet reached the launching stage, though the hull was completely plated and the masts, also of of all-welded construction, were likewise finished so far as the welding was concerned. Since then the Morag Mohr, as she is named, has been extensively tested in the Firth of Clyde and on the voyage round to the South Coast, and we were recently enabled to experience something of her qualities during several hours of sailing in a stiff breeze in the Solent.

Though full particulars of the vessel and of her scantlings and machinery were given on the previous occasion, it will be convenient to recapitulate the main dimensions. She has an overall length of 72 ft. 3 in., a beam of 16 ft. and a draught of 7 ft. The displacement is 45 tons. The hull has a round bilge, with a deep fin keel to give the necessary stiffness under sail. The keel, like the hull, is of welded aluminium alloy and contains 8 tons of cast iron, the pigs being set in a bituminous compound which performs the double function of preventing the iron from shifting and of insulating it from contact with the aluminium. The upper part of the keel, where it is attached to the hull, is of cellular construction, the compartments being used for the stowage of fresh water.

The hull is longitudinally framed, with nine transverse bulkheads, of which the fore and after peak bulkheads and the engine-room bulkhead are watertight. Over the middle portion of the hull the deck (also longitudinally framed, and laid with teak planking) is joined to the sheer strake by a radiused gunwale-bar instead of the usual angle to give increased strength. The frames are extrusions of channel section, and are spaced 3 ft. apart. The materials used in the hull are aluminium-magnesium alloys, the plates containing 4 per cent. of magnesium and the extruded sections 5 per cent. The keel bottom plate is $\frac{1}{2}$ in. thick, the shell plates $\frac{3}{8}$ in., the watertight bulkheads $\frac{5}{16}$ in. and the non-watertight bulkheads (which are riveted) of 16 s.w.g. sheet. The deckhouse is of double-skin construction, the outer sheet being 16 s.w.g. and the inner skin 18 s.w.g. The deck stringer plates are $\frac{1}{4}$ in. thick and the rest of the deck plating is $\frac{1}{8}$ in.

The two Gleniffer engines, which run at 1,000 r.p.m., are fitted at the forward end of the engine room and drive through Anderton clutches. There are no gearboxes, as variable-pitch propellers are fitted; they are three-bladed, 26 in. in diameter, and were supplied, with their controlling mechanism, by Slack and Parr (Marine), Limited. Both propellers and shafts are of high-tensile bronze. Two fuel tanks are provided, each holding 400 gallons, and are built into the hull structure to port and starboard of the engine room. A Stuart Turner 9 brake-horse-power auxiliary Diesel engine drives the 3-kW electricity generator and also a bilge pump. A second bilge pump, supplied by the Parsons Engineering Company, Southampton, is driven by the starboard main engine, and there is a third pump in the galley, operated by hand. The starboard engine also drives the Hyland hydraulic windlass for working the two anchors.

The Morag Mohr, a twin-screw yacht of all-welded aluminium-alloy construction.

Each main engine drives by belt a C.A.V. generator, delivering current at 24 volts. The double-plate rudder, like the hull, is fabricated of aluminium alloy, and can be operated either from the wheelhouse or from an outside steering position. The steering gear was supplied by Mathwin Marine, Limited. An emergency hand tiller can be fitted directly on to the rudder head through a fitting in the deck, normally covered by a cap.

The total sail area is 1,408 sq. ft. The mainsail and the mizen work in aluminium tracks welded to the masts and booms, and the foresail is also fitted with a boom and a similar slide. Two aluminium-alloy dinghies are stowed on the after deck. The larger, which is 12 ft. long, has a Stuart Turner engine and the smaller, 10 ft. long, can be fitted with an outboard motor if required. Both dinghies were built by Whittingham and Mitchel, Limited. The Morag Mohr has proved very satisfactory in service, only a few minor details having required attention. She is a good sea boat, sturdy yet handy, and proved notably dry in the short confused waves so characteristic of the Solent.

* * *

SMALL PORTABLE BORING MACHINE

A Logical Development of the Internal-Combustion Engine Re-Borer

The "Cent-ro-mic" portable fine-boring machine, designed and made by the " Buma " Engineering Company, Limited, Robson-street, Newcastle-upon-Tyne, 6, has been developed from the well-known portable machine used for re-boring internal-combustion engine cylinders. With a boring capacity of 2·2 in. to 4·2 in. in diameter and $10\frac{3}{4}$ in. maximum depth, it is well suited to a large variety of *in-situ* boring work. Typical jobs done by the machine include finish-boring in position the 16 bolting holes in a replacement cylinder for a steam hammer, boring bolt holes in ship propeller-shaft coupling flanges, and similar work on turbo-alternator casings.

The machine has a $\frac{1}{2}$-h.p. electric motor mounted on the main casting, which also carries the boring bar in Timken taper-roller bearings. Drive from the motor is taken by a single V-belt and a pair of three-step cone pulleys to a worm and wheel mounted at the rear of the main casting, and thence by a shaft to a gearbox with three spur gears which drive the boring bar. A worm-and-wheel take-off in this box drives the feed nut, through which the feed screw passes. Three boring speeds are available, 180, 320 and 460 r.p.m., and there is one feed of 0·0025 in. per revolution. The latter is engaged by clamping the feed screw.

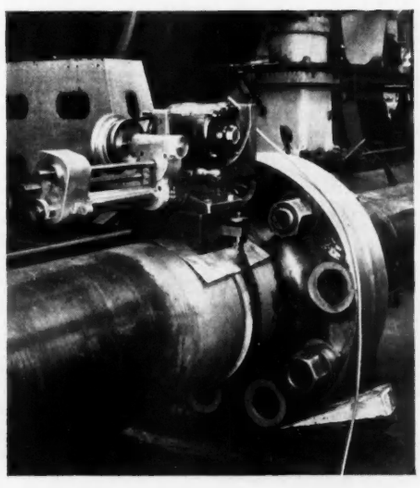
The base, or foot, of the main casting is machined with tenon slots and bolt holes for attaching to a saddle or other fixture as required, the distance between the machined face and the centre-line of the boring bar being $1\frac{1}{4}$ in. A special saddle, adjustable to suit varying pitch-circle diameters, can be supplied for use on a propeller shaft or for similar work, and other clamping devices, parallel or angular, can be made as required.

RAPID SETTING

The boring bar carries a single-point tool in a holder, which is retained in position by Allen screws. For setting to the correct diameter, a tool-setting fixture, with an integrally-mounted micrometer head, is supplied. This is used at any convenient point adjacent to the machine for setting the tool in its holder, after which the complete assembly is mounted in the boring bar. Centralisation of the machine relative to the hole to be bored is by means of three expandable blades in the boring head, controlled by a hand-wheel on the gearbox.

The machine is suitable for use with tools of any kind, but is specially designed to take advantage of tungsten-carbide tipped bits, a set of these tools being supplied with it. For re-grinding the tools a diamond-impregnated metal wheel is mounted on the driven shaft of the V-belt pulley assembly, and two tool-grinding fixtures, which mount on a lug on the shaft housing, are provided. To re-grind a tool it is only necessary to remove it from the boring bar, place it in position in one of the fixtures, and bring it into contact with the diamond-impregnated wheel. The setting of the tool is then adjusted with the setting fixture, and the tool is replaced in the boring bar. No external equipment is needed, the machine having all the facilities necessary for maintaining the tools in proper cutting condition.

The machine is normally supplied with motor and switch, two tool holders complete with tungsten-carbide tipped tools, two tool-grinding fixtures, diamond-impregnated wheel, tool-setting fixture, centring blades, Allen keys and storage case. The adjustable saddle for shaft work is available as an extra fitting; other saddles and clamping devices are designed to suit particular applications.



The " Cent-ro-mic " portable fine-boring machine can be fitted with saddles or other clamping fixtures to permit boring at any angle.

HIGH-HEAD MINE PUMP

No Moving Metal Parts in Contact

Megator Pumps and Compressors, Limited, 43 Berkeley-square, London, W.1, recently gave a demonstration of the latest addition to their range of pumps—the model GH4. This is intended primarily for use as an intermediate or between—levels pump for mines, and has a capacity of 160 gallons per minute against a head of 350 ft. For this duty a 30-h.p. motor, running at 960 r.p.m. is required; alternatively, a 20-h.p. motor can be used for heads of 200 ft. or less. Pump and motor are usually mounted on a skid base as shown in the illustration.

The principle of operation of these pumps has already been described (ENGINEERING, vol. 173, page 478, 1952), and can be seen from the accompanying sections. Briefly, an eccentric, running in a synthetic rubber shoe, which acts as a valve, draws in liquid from the two suction ports and delivers it through the single delivery port. The presence of high-pressure liquid in the body of the pump keeps the shoe sealed against the port plate. Capacity can be increased both by increasing the size of eccentric and shoe and by using a larger number of " cylinders." The GH4 has six " cylinders," the centre pair being arranged with the port plate on the opposite side of the pump to the two outer pairs, so that some of the load on the shaft is balanced. Like all the Megator pumps, the GH4 is self-priming and has excellent snoring ability, that is to say, it can pump a mixture of air and water without trouble.

In the GH4, the bearings consist of synthetic-rubber flanged bushes inserted in the bearing housing. The bushes house a large number of longitudinal grooves which serve both to lubricate the bearing and to remove debris by allowing a free passage for the water. The bearings also allow considerable side movement of the shaft when loaded; this is also possible for the eccentrics in the shoes. End seals on the shaft are made up from spring-loaded carbon rings running against a lead-bronze ring. Here again there is considerable freedom for shaft movement or misalignment; for the latter, the lead-bronze rings are backed by synthetic rubber which bears against the end cap. Free circulation of water around the seals prevents the accumulation of dirt, and both seals and bearings have given very long periods of service under abrasive test conditions without attention or renewal. Thus in the GH4 pump there is no contact between moving metallic parts at any point. Seals are fitted at both ends of the shaft to avoid the need for a thrust bearing.

To take full advantage of the flexibility, and to accommodate any movement resulting from normal wear, a special flexible coupling was designed using the Metalstick trailing-link mechanism that is to be seen in the diagram. Also, since the end-seals and bearings cannot be split, Taperlock bushes have been used to hold the two halves of the coupling. That on the motor shaft has its large end inwards, so that for removal the hub can be slid back along the shaft. This allows room for the hub to be drawn off the pump shaft and then for the end cover and bearing housing to be removed without disturbing the alignment of the motor and pump. As with other Megator pumps, the shoes and eccentrics can be reached for examination or replacement by removing a side cover and the port plate. No other disturbance is necessary.

* * *

COUPLING WITH EASILY REPLACEABLE FLEXIBLE MEMBERS

A flexible coupling claimed to allow for considerable radial, angular, and axial mis-alignment of the shafts has been produced by Owl Engineering Supplies, Limited, 16 South Parade, Doncaster, Yorkshire. The coupling, called the Multicross flexible coupling, is shown in the accompanying illustration. It consists of two independent hub flanges and two end plates; each end plate is secured to its hub flange by retaining screws, which can be seen clearly in the illustration, and one end of a U-shaped rubber cushion, reinforced with nylon, is clamped between the flange and end plate. The other end of the rubber cushion is clamped between the other flange and end plate. The coupling shown uses three rubber cushions to connect the two hub flanges, but for transmission of larger powers more rubber cushions would be needed.

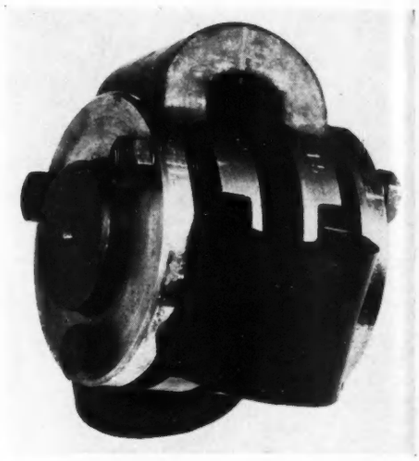
This coupling gives a good degree of flexibility, and provides protection to both driving and driven machinery because of the adequate damping effect on vibration and the absorption of shocks. The rubber cushions can easily be replaced by slackening the retaining screws on each end plate and removing the old cushions. Three sizes of rubber cushion cover the whole range of couplings available, from fractional up to 70 h.p. Each size of cushion caters for six sizes of coupling which vary from each other by the number of cushions employed.

* * *

HYDRO-ELECTRIC GENERATION IN ULSTER

A scheme for two hydro-electric generating stations on the River Mourne has been announced by the Northern Ireland Ministry of Commerce. It provides for the construction of a dam and 18-MW generating station at Mulvin, and a dam and 9·5-MW generating station at Sion Mills, at a total cost of £3,750,000. It is estimated that the two stations together should be able to supply 78 million kWh annually, equal to 9 per cent. of the total quantity sold in Northern Ireland in 1954. The overall cost of producing these units should be about £100,000 less than their cost of production in a modern coal-fired station, and the annual saving of coal should be 47,000 tons.

The scheme provides for electrical interconnection of the stations, and for their connection to existing power sources. One purpose of the scheme is to extend the main high-tension transmission system from its present terminus at Omagh to the new stations. At present, the principal generating stations are at Belfast and Ballylumford on the east coast, and the provision of generating stations which would add their output to the system at the point now proposed would increase the efficiency of the transmission system in the northern and western areas. Copies of the scheme and an explanatory note will be available for inspection until July 23 at local authority offices in County Tyrone, at the Belfast, Omagh and Strabane offices of the Electricity Board for Northern Ireland, and at the Ministry of Commerce, Chichester House, Chichester-street, Belfast.

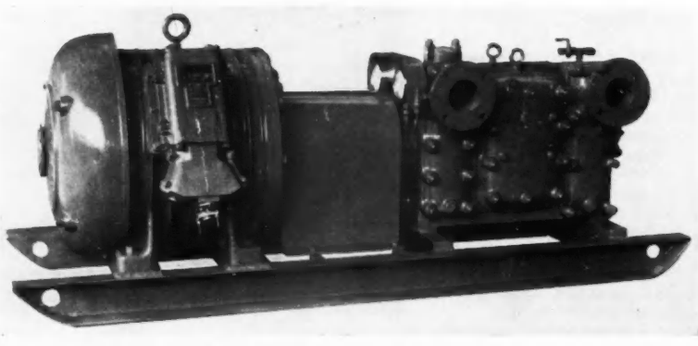


Torque is transmitted through this flexible coupling by the three nylon-reinforced rubber cushions which are clamped between the two hub flanges and end plates.

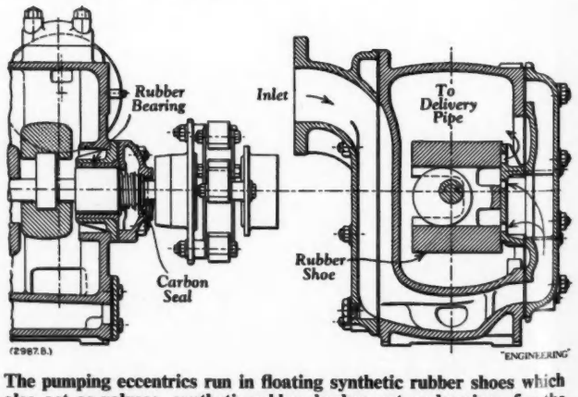
* * *

LIGHT-WEIGHT COVERED LORRY

A general-purpose lorry has been equipped with an aluminium body and canopy by the Midlands Electricity Board, working in conjunction with the Northern Aluminium Company, Limited, Banbury, Oxfordshire. The body weighs approximately 9 cwt., which is about 7 cwt. less than the corresponding wooden structure, and is mounted on an Austin 2/3 ton chassis. Dimensions of the body are: 12 ft. long, 6 ft. 4 in. wide, and 5 ft. 10 in. high, including the canopy. The body can be removed by two men, leaving an open lorry with sides 20 in. high.



With a 30-h.p. motor, the GH4 pump will raise 160 gallons per minute against a total head of 350 ft.



The pumping eccentrics run in floating synthetic rubber shoes which also act as valves; synthetic-rubber bushes act as bearings for the shaft and spring-loaded carbon rings form the end seals.

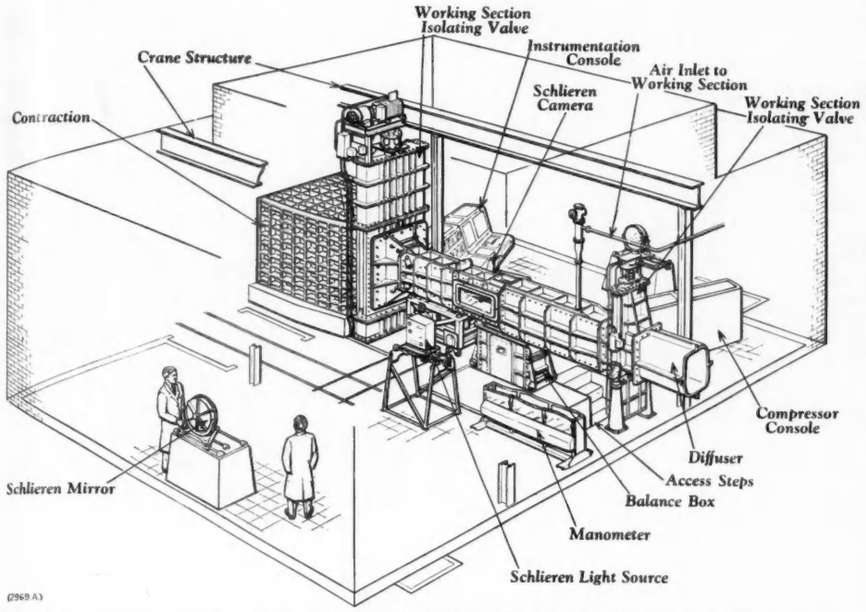


Fig. 10 Interior of control room, showing disposition of working section, isolation valves, the instrumentation and compressor consoles, and the schlieren camera, light source and 18-in. mirrors.

CONTINUOUS SUPERSONIC WIND TUNNEL

2—CONSTRUCTION AND ANCILLARY EQUIPMENT

Concluded from page 800 (*vol.* 179)

In the continuation of our article on the supersonic wind tunnel built by Sir W. G. Armstrong Whitworth Aircraft Limited, for testing aircraft and guided missiles in the 0·3 *to* 3 *Mach range, we give further details of its construction together with descriptions of certain ancillary plant.*

CAST-IRON WORKING SECTION

There are two essentials to be observed in the design and manufacture of supersonic working sections, namely rigidity and internal smoothness. It was decided to avoid the conventional steel box containing replaceable wooden liners, and in order to achieve the maximum rigidity, the top and bottom of the working section were machined from iron castings designed as a channel section to the approximate contour of the calculated nozzle, with integral cross ribs and end flanges. The contoured surface of these castings, which form the horizontal walls of the working section, was profiled from a cam bar of high accuracy. A pair of castings is required for every Mach number but the total cost differs little from that when wooden liners are used, while subsequent shrinkage is eliminated and distortions greatly reduced. The nozzle castings were bolted between identical steel side plates, the inside faces of which were ground flat. These side plates were fabricated and machined to very fine limits.

The nozzles are of such a length that any shock waves thrown off from the joint of nozzle and liners will pass harmlessly behind the model. However, the windows for flow photography must be opposite the model, and consequently the model must lie behind their leading edge. This possible discontinuity in the surface leading edge of a removable window always presents a difficulty, particularly with circular windows, which give rise to a shock wave of curious shape. One rather cumbersome solution is to remove the whole side of the working section to give access to the model, but it was decided instead to have a rectangular window and frame, the vertical leading edges of which may possibly give rise to a pair of plane crossed shock waves in the working section.

Provision has been made to adjust the model longitudinally in the tunnel (see Fig. 12), to enable these shocks to pass harmlessly in front of the nose, and the reflected shock from the walls to clear the tail of the model. A plane shock of small amplitude will not upset the uniformity of Mach-number distribution. The windows are hinged on to the balance section and only the section comprising nozzle blocks and side plates is wheeled out on the trolley when changing Mach number. Finally, a boundary-layer allowance of 0·002 in. per inch has been made on all four walls, and in the case of the M = 1·9 working section, this allowance may be increased on the top and bottom.

BALANCE SECTION WITH HINGED LINERS

The balance section consists of a rectangular shell with a glass window in the top to be used for yaw measurements. Into this shell are fitted the hinged liners, shown in Fig. 11, the vertical ones engaging with the small side plates bolted to the balance-section shell; a tapered support is fitted between the shell and the liners when the installation is set for series working of the compressors.

The horizontal liners have interchangeable slide-in inserts to cater for both widths of working section; they also engage with the ends of the nozzle castings over the range of working-section heights.

On to the bottom of the balance section is bolted the balance box in which the balance carrying and incidence mechanism is mounted. This box is designed to be easily removable, complete with its contents, for maintenance and adjustment.

CONTROLLING THE MODEL: INCIDENCE

The incidence gear shown in Fig. 12 consists of two struts carrying the balance and model, keyed together and each driven by an electric motor. A third motor traverses the whole assembly horizontally parallel with the axis of the tunnel. By moving both struts together the model may be raised or lowered, and by moving one relative to the other, the angle of of incidence may be changed. Controls are provided whereby one of a large range of incidence angles (between −6 deg. and 45 deg. in increments of 0·1 deg.) can be selected on a dial; a servo-mechanism stops the gear when the selected incidence has been reached. An incidence indicator gives the difference in position of the struts.

An incidence-gear control unit ensures that the model rotates about a predetermined point during changes of angle of attack, and thus provides a movement similar to that which might be obtained with a sector-type gear of variable radius and position. This unit enables the model to be located so that it avoids the worst pair of crossed shock waves in the tunnel;

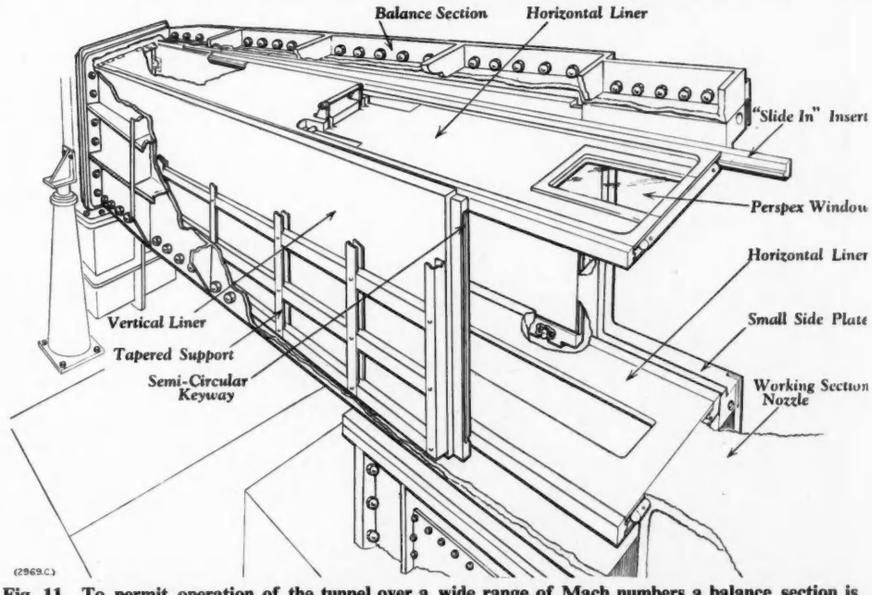


Fig. 11 To permit operation of the tunnel over a wide range of Mach numbers a balance section is provided. Alterations are effected by means of two sets of hinged liners, one vertical and the other horizontal, which may be adapted for use with both widths of working section.

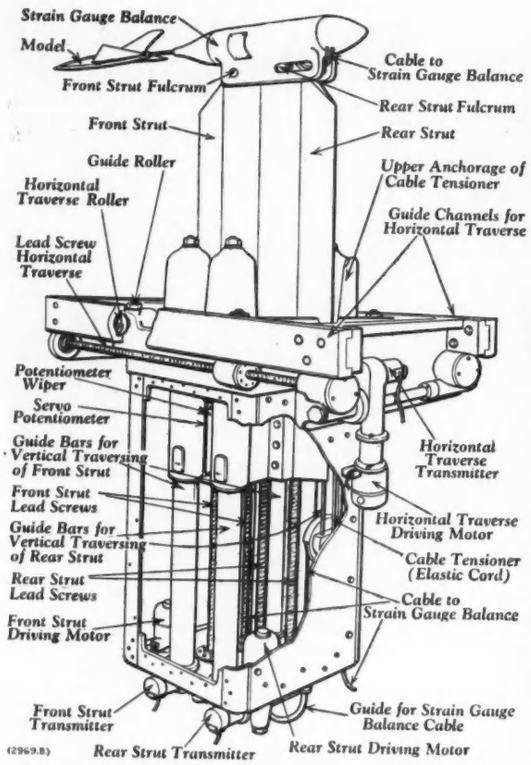


Fig. 12 The incidence and traverse mechanism. The incidence gear consists of two struts; by moving both struts together the model may be raised or lowered, by moving one relative to the other the angle of incidence is altered.

experience in preliminary trials has shown that this adjustment is likely to be an essential feature of newer tunnels, since large changes of moment occur when a small shock wave impinges on the conical nose of a body. The readings settle down to a steadier value when the model nose is retracted behind the shock. The operator can override the automatic mechanism and control any of the three model-positioning motors by hand; automatic operation based on the new zero position set by the operator is subsequently resumed.

ROLL BALANCE

The front end of the model is attached to an internal strain-gauge sting, and by measuring bending moments at two stations in perpendicular directions, the normal force, side force, pitching moment and yawing moment can be calculated, leaving rolling moment and drag force to be measured by a separate balance at the rear of the model.

To simplify balance design, separate balances have been constructed for roll and drag. The roll balance consists basically of a heavy spindle, mounted in ball races and restrained from rotating by a strain-gauge fitted cantilever attached at the "fixed" end to a gearbox. The gearbox and spindle are driven by a small electric motor, thus enabling the roll angle to be altered remotely. A combination of pitch and roll will simulate any given combination of incidence and sideslip angles, while rolling moments are measured by the strain-gauge cantilever.

The roll balance body houses a potentiometer on which slides a lightly-sprung platinum wiper attached to the spindle. This potentiometer, together with the associated roll servo-equipment, enables the roll angle to be adjusted remotely over 200 deg. to an accuracy of 0·1 deg. by turning a pointer on the control console to the angle required.

The roll balance incorporates the standard sting taper mounting and fittings brought from the Ordnance Aerophysics Laboratory, Daingerfield, Texas, by Armstrong Whitworth Aircraft, and is now in use at the Royal Aircraft Establishment and certain other tunnels.

SELF-BALANCING STRAIN-GAUGE EQUIPMENT

To avoid trouble due to mains pick-up, the strain-gauge equipment, which has six channels and is self-balancing, employs a 625 cycles per second gauge supply derived from a high-stability oscillator. The reading is presented on a circular dial, and readings to one part in a thousand may be obtained without sub-division.

Fig. 14 Schlieren camera set for photographing model. Shock waves are formed in the manner indicated in Fig. 13 when air flows past the model at supersonic speeds.

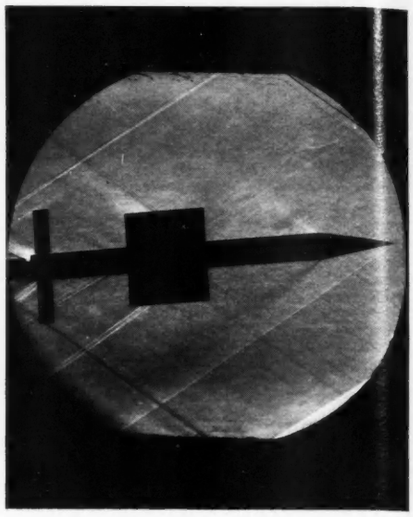


Fig. 13 By means of the schlieren camera shown in Fig. 14, photographs of shock-wave patterns can be taken.

The sensitivity or "balance range" is adjustable in six steps, and the least sensitive range gives a full-scale reading with 0·6 per cent. strain and the most sensitive range with 0·01 per cent. strain. Each channel incorporates a step repeater transmitter, coupled to a motor in the printer for automatic printing of results; the sensitivity switches have a similar transmitter mechanically coupled for the purpose of making recordings.

On the far side of the working section in Fig. 10 can be seen the instrumentation and balance console, which incorporates the six strain-gauge channels, the roll-angle and incidence servo-mechanisms, in addition to switches and push buttons for the schlieren system, manometer camera, incidence mechanism, printer recorder and other equipment. Thus it will be seen that all the essential controls are grouped together, and if necessary, one technician is able to record the balance readings, take schlieren and manometer photographs, and control the attitude of the model. The dials on the strain-gauge units can be read directly, or by pressing a button they can be simultaneously printed in triplicate, together with all other relevant data by the printing unit housed in a smaller console alongside the balance console.

PRINTER RECORDER UNIT

The printer is housed in the console and is operated by pressing a "print" button, whereupon the servo current is cut, freezing the readings. The step repeaters round off the readings to the nearest digit, and readings in 22 channels are then printed simultaneously, including six strain-gauge channels, six sensitivity recordings, roll and incidence angles, both model positions, run number, and other channels for date, barometer, stagnation pressure, and so on.

After printing, the paper is automatically traversed, and the traversing mechanism is arranged to give a wider line spacing, after every five prints, to facilitate reading of the printed sheet. The top carbon sheet is automatically rolled on to a spool to enable the printed results to be observed. A cutter wheel is provided to enable the printed paper roll to be divided into sheets suitable for filing, and a selector mechanism warns the operator when any previously determined number of prints has been taken. This helps to prevent the printing of "non-standard" sheets. A shot counter is built into the machine together with a hand-setting device to simplify the recording of information which cannot be transmitted automatically.

SHOCK-WAVE PHOTOGRAPHY

The pair of 18-in. diameter mirrors shown in Fig. 10 form the basis of an automatic schlieren system which enables shock-wave patterns to be photographed in the manner illustrated in Fig. 13; the schlieren camera itself is shown in Fig. 14. The balance observer can glance at the camera screen press a button adjacent to the print button, and photograph by spark schlieren (microsecond duration) the image that he sees. The viewing image is suppressed for a moment during the actual automatic exposing sequence. Direct shadow pictures can also be taken by obscuring the window and extinguishing the lights, while the light source, camera and mirrors can be traversed in a direction parallel with the working section so that pictures can be taken with the model in any longitudinal position.

The tunnel equipment also includes a pressure-plotting manometer, which has 90 tubes; readings are recorded on an F24 aircraft camera which is controlled remotely from the balance console. The main camera incorporates an auxiliary camera for photographing a serial or shot number on the corner of each frame.

It is intended to record all the wind-tunnel data on 5-hole punched tape for reduction in an electronic computer.

An important section of the tunnel equipment is the air drying and compressing plant. A 90-h.p. compressor is provided, which may be used to evacuate the tunnel or alternatively, to compress atmospheric air to 100 lb. per square inch for passing, through an activated-alumina dryer to 1,700 cub. ft. storage vessels. It can then be admitted to the tunnel circuit or working section as required, or used to drive a subsidiary 10-in. by 8-in. intermittent tunnel.

Control of all this plant is centralised in a single panel of the plant control desk, where an illuminated mimic diagram enables the cycle of operations to be traced. The tunnel can be pressurised to 26 lb. per square inch in one minute from the storage, or evacuated to 1/3 atmosphere in 20 minutes by the pump.

Under vacuum conditions, a dry air supply is maintained to labyrinth glands at the end of the compressor shafts to prevent the influx of wet air into the tunnel circuit. Half a pint of water in vapour form is enough to prevent useful operation of the tunnel, due to condensation of fog in the working section; this upsets the temperature, and hence the speed of sound and Mach number. During runs, the 90 h.p. pump is used to re-circulate air from the tunnel through the dryer and back into the tunnel.

Two 75-h.p. water pumps each pumping 1,200 gallons per minute from the River Sowe, supply the cooling needs of the tunnel; most of this passes through the air cooler, which can reduce the tunnel air to below room temperature. Water is also supplied to the oil cooler and liquid starter cooler. The water returns to the river under gravity through a storm sewer, and its temperature rise is limited to 7 deg. F.

In addition to Sir W. G. Armstrong Whitworth Aircraft, Limited, the following companies have supplied plant for the wind-tunnel installation: Daniel Adamson and Company, Limited (main compressors, cooler and tunnel shell); Bruce Peebles and Company, Limited (main electric motor); David Brown and Sons, Limited (gearbox); Revo Foundry Company (contraction, nozzle and window castings); Rotork Engineering Company, Limited (working-section isolating valves); Hamilton Woods and Company (3-ft. sluice valve); Optical Works, Limited (18-in. mirrors and optical polishing of windows); Pilkington Brothers, Limited (windows: schlieren-quality plate glass); Broom and Wade, Limited (90 h.p. air compressor/evacuator); Birlec, Limited (dryer), John Thompson, Limited (air receivers); Gwynnes Pumps, Limited (water pumps); and Allen West, Limited (electrical switch gear). The control room, working section, compressor-control and instrumentation consoles, and the light source and camera were made by Sir W. G. Armstrong Whitworth Aircraft Limited.

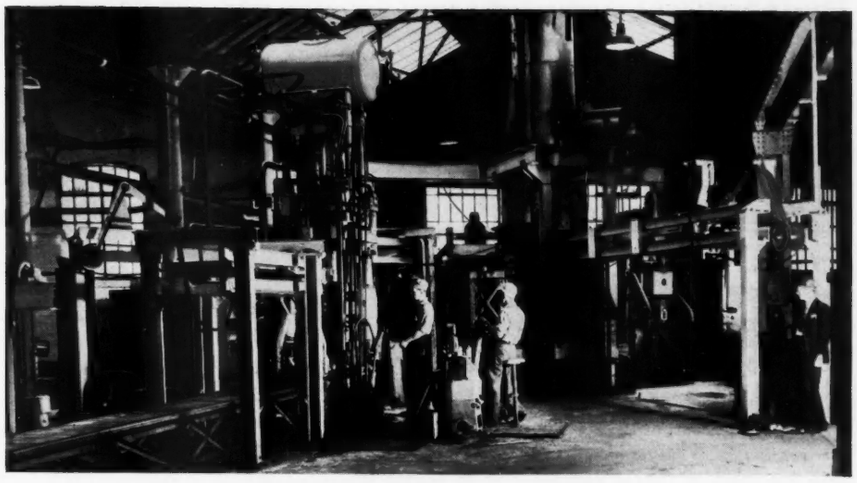


Fig. 1 The rotary furnace, which is fired by coke-oven gas, and the 400-ton hydraulic shaping-and-punching press for piercing hot blanks. The blanks are then taken to the ring-rolling mill shown in Fig. 2.

RING ROLLING AND AXLE FORGING

STEEL, PEECH AND TOZER'S WORKS, ROTHERHAM

Several new developments have recently taken place in the Rotherham works of the Steel, Peech and Tozer Branch of the United Steel Companies Limited, 17 Westbourne-road, Sheffield, 10, and as these have an important bearing on production and, as such, are of interest to steelworks engineers, they are described below in some detail.

RING-ROLLING PLANT

For many years ring forgings for ball races for the bearings industry and, more recently, for the aircraft industry, have been produced at the Steel, Peech and Tozer works. Hitherto, the work has been carried out by forging under steam hammers, but, to enable the range of sizes to be increased and to speed up the process a new ring-rolling plant has been installed at the Ickles Works of the firm at a cost of £90,000 and is now in production.

The installation is expected to produce rings at a rate of 60 per hour; it is capable of dealing with work having a maximum weight of 2½ cwt., and an outside diameter of from 5 in. to 50 in. Rings having a diameter of 5 in. and below can still be produced by steam hammers or, where quantities permit, in a high-output upset-forging machine.

The new ring-rolling plant comprises two annealing furnaces, cold saws, a rotary-hearth gas-fired heating furnace, a re-heating furnace for use when necessary, a 400-ton forging and piercing press, a ring-rolling mill and three air-operated chuck lathes.

Round steel bars, produced at the firm's adjoining Templeborough shops, are supplied in lengths of from 12 to 15 ft. After annealing where necessary, blocks of the required weight are cut by means of the cold saws. The weight of the block is calculated from the finished ring weight, due allowance being made for punching, scale and machining losses and each block is check weighed after being sawn from a bar.

ROTARY-HEARTH FURNACE

The blocks are charged as required into the rotary-hearth furnace by means of a magnetic charging machine. Here they are heated to the requisite temperature, usually up to 1,200 deg. C. The furnace is fired by coke-oven gas; the diameter over the hearth is 12 ft. 3 in., the height from floor level to hearth 3 ft., and the diameter of the overall steelwork 17 ft. The furnace roof is static and the main body of the furnace rotates; it is fitted with automatic temperature-control equipment and is divided into soaking and heating zones. The furnace is capable of heating 120 blocks an hour and a discharging machine picks up the blocks one at a time and places them on a conveyor which takes them to the adjoining punching press. The rotary-hearth furnace and the charging and discharging machines have been supplied by the International Furnace Equipment Company, Limited. The furnace and the magnetic charging machine are seen in the background in Fig. 1.

400-TON PIERCING PRESS

The upsetting and piercing press, of 400 tons capacity, seen in the centre in Fig. 1, has been supplied by the Loewy Engineering Company, Limited, and is capable of upsetting blanks of up to 150 lb. in weight to 12 in. in diameter. Blanks above this weight and size are produced on a large air hammer. The press is of conventional hydraulic design and is operated by pumps and and air-loaded accumulator; it has a maximum working pressure of 2,850 lb. per square inch.

When a block from the rotary-hearth furnace is placed in position under the press it is centralised by a pair of hydraulically-operated arms and is forged down to the required dimensions. This operation is followed instantly and automatically by an upper central punch which travels through the block to a predetermined depth. With the upper punch in this position, a lower central punch is brought into action and travels upwards until the flow of metal ceases. The distance between the two punches at this stage constitutes the only discard. The upper punch is then withdrawn to its original position and the lower punch continues upwards to remove the small slug to the top of the blank. A pusher device then places the pierced blanks on the conveyor seen on the left in Fig. 1, which takes the blank directly to the ring-rolling mill. Here the blank is placed in position on the mill spindle and the rolling carried out.

RING-ROLLING MILL

Also of Loewy design and manufacture, the ring-rolling mill, seen in Fig. 2, is compact and occupies comparatively little floor space. The maximum size of ring which can be accommodated has an outside diameter of 50 in., and a maximum height of 9½ in. The larger outer roll and the smaller inner roll of the mill are each driven by electric motors, of 100 h.p., and 3 h.p., respectively. The inner roll is carried, top and bottom, in a tapered cone through which the necessary adjustment for ring width can be

Fig. 2 The ring-rolling mill to which the pierced blanks are delivered. The dial indicator informs the operator when the correct wall thickness has been obtained in the ring.

obtained. The upper end of the spindle, which is supported in the top cone, is carried on a pivot shaft. The outer and inner rolls are brought together by means of a system of hydraulic cylinders and for the purpose of guiding the hot ring during rolling, a pair of rollers are placed on each side of the larger roll. The final rolled-ring size is checked by a gauging device connected to the large dial seen in Fig. 2; this measures the diameter of the rolled ring by means of a roller that is in contact with its outer circumference.

After each rolling operation, the pivoted arm of the ring-rolling mill is raised hydraulically and swung out sideways so that the next blank can be loaded into the mill.

A team of three operators controls the charging and discharging of the rotary furnace and the forging press while two employees charge and control the mill. After rolling, rings which require annealing are charged into a bogie-type furnace. All rings are then conveyed to the chuck lathes by means of pallets and fork-lift trucks. Here the faces of the rings are machined to size, after which final inspection for dimension and quality is carried out and the rings are ready for dispatch.

NEW AXLE FORGE

Included in the United Steel Companies' post-war programme for modernising their railway-materials department was the provision of a new axle forge, costing £150,000. This has recently been completed in the Ickles works of Steel, Peech and Tozer.

The forge is housed in a special building consisting of two bays, the main one being 70 ft. wide by 320 ft. long and the secondary bay 55 ft. wide by 240 ft. long. The height to the apex of the roof of the main bay is 65 ft. The equipment provided includes a 10-ton electric overhead travelling crane, a continuous gas-fired furnace, an electro-hydraulic mechanical manipulator, a 7-ton steam-operated hammer, a heat-treatment furnace, a quenching tank, a straightening press and ending saws.

Steel blooms from the firm's Templeborough rolling mills are heated to 1,250 deg. C., in a continuous furnace, built by G. P. Wincott Limited. This has a width of 8 ft. 6 in. and an effective length of 37 ft. 6 in. Heating is by low-pressure coke-oven gas and the furnace is designed to heat 100 blooms, 7⅞ in. square by 56 in. long, from cold to 1,250 deg. C. during a 7½-hour shift. The blooms are charged in at one end by an electric pusher and the normal heating period is approximately 5 hours. When a bloom has reached the correct temperature, it is ejected separately by a friction-roll pusher, operating at right angles to the centre line of the furnace, on to gravity rolls from where it is picked up for forging.

FORGING MANIPULATOR AND HAMMER

Throughout the forging process, the bloom is held by a 6,000-lb. low straight-line bridge-type manipulator of the non-revolving type, operating on a track set at 25 ft. centres, 102 ft. long, running in front of the 7-ton hammer. The manipulator, which has been supplied by the Adamson-Alliance Company, Limited, is seen in Fig. 3. The tongs both grip and revolve; they receive power for gripping from a revolving hydraulic cylinder and the revolving motion is controlled by an oil-hydraulic motor. The operator of the manipulator is protected from heat and flying scale by a special heat-resisting safety-glass screen and from shock by special springing devices. The bloom is forged at one heat and the turntable necessary to rotate it through 180 deg. is mounted on the front of the manipulator frame and controlled by an independent pump unit operated by the manipulator driver.

The 7-ton Massey steam-hammer provided for forging and seen in Fig. 3 has a stroke of of 50 in. and a working pressure of 90 lb. per square inch. The base plate is of cast steel and the 120-ton cast-iron anvil block has a 20-ton steel top. Jets of water can be played on the bloom during forging, thus ensuring the removal of scale and a clean finish to the forging.

Heat treatment of the forged axles is carried out in a furnace having a sloping hearth 32 ft. long and 11 ft. 8 in. wide, heated by coke-oven gas. When necessary the axles are oil-quenched, after which they are allowed to roll on to the cooling racks. Finally, the axles are straightened in a 150-ton press and cut to length. Apart from those which are supplied direct to clients in the " as forged " condition, the axles are sent for machining to another local firm, Owen and Dyson, Limited, also a subsidiary concern of the United Steel Companies Ltd.

ANCILLARY PLANT

To cope with demands for axles when, for any reason, the new 7-ton hammer and its equipment are out of service, an existing 5-ton hammer has been transferred to the new axle-forge building. Normally, this hammer operates as an independent unit on general forgings. It is served by two new batch-type gas-fired furnaces, situated one on each side of the hammer. Each furnace is served by a 4-ton electrically-operated jib crane having a working radius of 21 ft. The bloom and the forging equipment are supported by an endless burden chain.

PRODUCTION-CONTROL QUANTOMETER

Supplied by Applied Research Laboratories, Glendale, California, U.S.A., through their European branch in Lausanne, Switzerland, a Quantometer has been installed in a specially air-conditioned room at Ickles works, where temperature and humidity are controlled with close limits. As our readers are, no doubt, aware, the Quantometer is a direct-reading instrument designed for rapid routine spectrographic analysis. It consists of a source unit which supplies power to the spark gap, a spectrometer, and a recording console. The installation covers the analysis of plain-carbon steels for residual elements, alloy steels of the nickel, chromium, molybdenum type, sinters for charging into the blast furnaces in other works of the United Steel Companies, and various types of steelworks slags. The selected constituents for analysis are phosphorus, silicon, manganese, nickel, chromium, tin, copper, molybdenum, aluminium, vanadium, titanium, lead, and boron in steels, and silica, iron, lime, phosphorus pentoxide, manganese oxide, magnesia, alumina and fluorine in slags and sinters. Up till the present, carbon, sulphur and the gas contents of steels cannot be determined by the Quantometer.

The instrument is pre-calibrated by an adequate series of homogeneous and accurately-analysed standard samples covering the ranges of concentration desired. Working curves are prepared relating recorder readings to percentage concentration.

The apparatus is in production use for most of each day of 24 hours. Bath samples are taken from melts and dispatched to the laboratory by pneumatic tube. On receipt, the sample is prepared by grinding on a horizontal grinding machine and finished on a band facing machine. It is analysed for the requisite elements and the results dispatched back to the melting shops by a small electronic instrument which reproduces a facsimile of a written message at the receiving end. The time occupied between the dispatch of the sample to the laboratory and the receipt of the results is stated to be about 9 minutes.

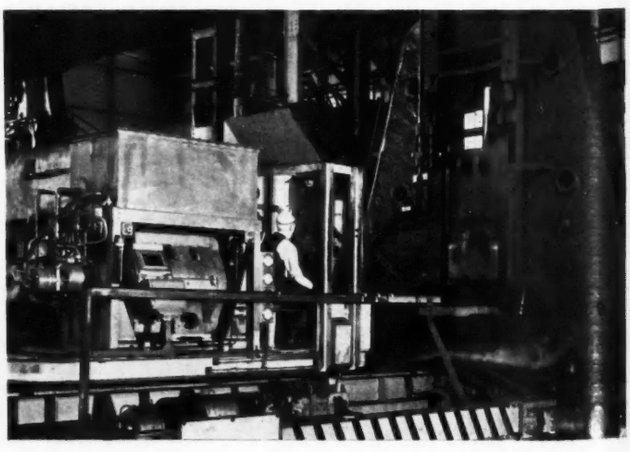


Fig. 3 Railway-wagon axle being forged by the 7-ton steam hammer. The manipulator holds and revolves the bloom during the operation.

Fig. 1 A development of the David Brown traction control unit is its application to this trailer; when going is difficult, weight from the trailer is transferred to the tractor rear wheels for increased adhesion.

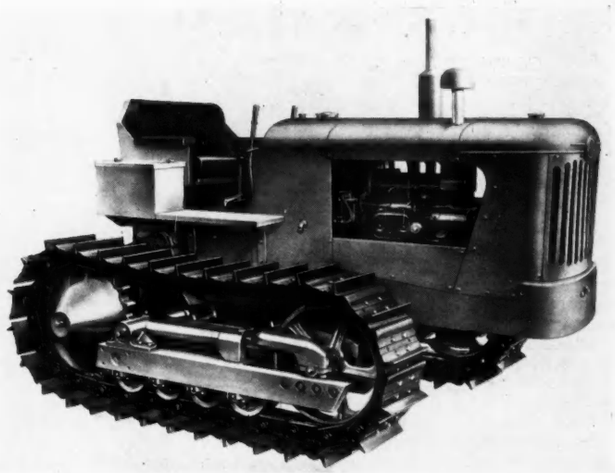


Fig. 2 The Track-Marshall Diesel-engined tractor has a maximum drawbar pull in first gear of 12,000 lb. The driver has a comfortable and adjustable seat, and a wide selection of ancillary equipment is available.

THE ROYAL SHOW AT NOTTINGHAM

The 107th Royal Show opens at Wollaton Park, Nottingham, on Tuesday, July 5, and remains open until the evening of Friday, July 8. Nottingham is in the centre of a great agricultural area, and the Royal Show has previously been held there in 1888, 1915, and 1928. This year's Show will be the largest ever staged, and visitors from overseas are expected to equal, if not exceed, the record figure of 3,000 at last year's Show at Windsor. There is much to interest everyone at the Show, including as it does horses, cattle, goats, sheep, pigs, forestry exhibits, honey and bee appliances, wool, cider, perry and cheese exhibits, sheep dog displays, jumping competitions, and displays of farm implements and machinery. In this last section there is much that is new; some items will be described this week and more in a subsequent issue.

5-FT. COMBINE HARVESTER

On the stand of David Brown Tractors (Engineering), Limited, Meltham, Yorkshire, will be the David Brown Albion 5-ft. combine harvester, which is to be built at the Leigh factory of Harrison, McGregor and Guest, Limited, in which David Brown have recently acquired a controlling interest. This combine harvester is the British version of a well-proven machine designed by one of Sweden's leading manufacturers of harvesting equipment. The combine is designed so that the cutter bar is in line with the threshing unit, and therefore no change of direction is involved for unthreshed crops or straw. Setting of the concave in relation to the threshing drum is recorded on an indicator, and adjustments can be made while the combine is running. The short-straw sieve has an exterior adjustment, which can be changed during work, and a special extension sieve is provided for seed threshing.

Drive is from the power take-off of a tractor, and the drive shaft speed is 535 r.p.m. The threshing drum speed is 1,400 r.p.m., and the drum is 3 ft. 11 in. in length and has a diameter of 1 ft. 6 in. The reel has two speeds, one for normal working and one for use in laid crops. A special safety coupling on the elevator enables the tractor driver to prevent potential obstructions from reaching the threshing drum.

The crop is carried up by the canvas elevator to a special three-bladed feeding drum from which it passes to the threshing drum, which carries ribbed beater bars working against a fixed concave. The greater part of the grain falls through the concave on to the top sieve. Any corn carried along with the straw to the shaker falls, thanks to the shaking motion, on to the sieve. The straw is carried from the threshing drum by a special stripping drum and distributed evenly over the whole of the shaker.

Dressing of the threshed-out material is effected on the adjustable short-straw sieve and the appropriate lower wind sieve in conjunction with a strong air blast from the fan, which blows away short straw and chaff. The cleaned grain falls down on to the inclined plane under the wind sieve and is led from there to the grain auger and so by the bagging elevator to the bags. Any broken ears that have not been threshed out are caught by the check-plate, so that they pass by way of the inclined plane to the return auger and then from the return elevator to the drum.

Overall dimensions of the combine are: length, 20 ft. 2 in.; transport width, 9 ft. 3½ in.; track width, 6 ft. 11 in.; and net weight 3,223 lb.

DEVELOPMENT OF TRACTION CONTROL UNIT

At the Smithfield Show last year, David Brown exhibited their traction control unit for giving greater rear-wheel adhesion, which was described in ENGINEERING for December 17, 1954 (vol. 178, page 802). The success of the T.C.U. has prompted the company to produce a trailer attachment working in conjunction with the control unit. The illustration of Fig. 1 shows the arrangement with a hydraulic 3-way tipping trailer made by F. W. Pettit, a recent addition to the David Brown range of approved equipment. The principle of the device is that, when the traction control unit is applied, the hydraulic lift attempts to raise the trailer bodily, like a mounted implement, thus transferring weight to the tractor rear wheels.

The tractor-trailer modification comprises a headstock assembly mounted above the trailer drawbar to provide an additional attachment point immediately above the normal trailer drawbar clevis. The headstock assembly can be clearly seen in Fig. 1. The additional attachment point is fitted with a swivel block to take a conventional top link ball end fitting. The special drawbar attachment consists of a hitch plate, fitted to a small lift frame which is connected to the normal lower hitch brackets and to the hydraulic unit lift arms. The top connection is a special short top link assembly.

The tractor-trailer is free to hinge when steered about a vertical pivot axis passing through the lower clevis connection and the top swivel block on the headstock assembly. It is also free to articulate torsionally to allow for uneven ground, due to the freedom in the ball joint connections in the top link and swivel block assembly. Although this tractor-trailer combination is semi-rigid laterally, it is free to articulate when travelling over rough ground with a parallelogram action as with a mounted implement.

Advantages claimed for the new T.C.U. development are: when difficult conditions are encountered weight can be transferred from the trailer to give increased tractor rear-wheel adhesion; with the linkage arrangement used, down load on the tractor drawbar is supported at a point within the tractor wheelbase, thus avoiding any tendency for the front end to lift; the special drawbar arrangement can be used as a pick-up hitch when connecting up the trailer.

Also on David Brown's stand will be a new associated implement recently approved for use with David Brown tractors. It is the lightweight horndraulic loader, which is mounted within the tractor wheels. It is easy to fit and

Fig. 3 The Dykan ditcher is designed to be attached to tractor fore-end loaders. Using the equipment shown, the spoil can either be deposited on the ground or in a trailer or lorry up to a height of 7 ft.

manoeuvrable in confined spaces, it has a capacity of 9 cwt. and a lifting height of 10 ft.

CRAWLER TRACTOR WITH 12,000 LB. DRAWBAR PULL

On the joint stand of Marshall, Sons and Company, Limited, Gainsborough and John Fowler and Company (Leeds), Limited, will be a new tracklaying tractor called the Track-Marshall, shown in Fig. 2, page 29. It has a Diesel engine, and has been designed for heavy agricultural duties and medium-scale earth moving. The engine is the Perkins L4 developing 48 brake-horse-power. A 12-volt induction heater and a primer pump are provided as cold starting aids, and the starter itself is of the 5-in. axial type. Steering is by controlled differential with hand steering levers operated on each side of the steering unit, and power is delivered to both tracks at all times.

Tracks and track rollers are identical with the Fowler Mark VFA, and all track pins, bushes, links, rollers and certain other components are hardened by the electrical induction process, ensuring long life with maximum resistance to wear and shock. The normal track width is 14 in. The cranked front axle permits independent oscillation of each track and at the same time ensures continuous and perfect track alignment. A comfortable bench-type seat and all-round visibility provide complete control of both tractor and implements without undue physical effort. The seat has a horizontal movement to 3 in. fore and aft allowing a choice of positions for the driver.

There are five forward and two reverse speeds; in 1st forward gear the speed is 1·31 m.p.h., in 5th 5·15 m.p.h.; the two reverse speeds are 1·01 and 2·13 m.p.h. The maximum drawbar pull in 1st gear is 12,000 lb. Overall dimensions are length, 10 ft. 1 in., width 5 ft. 10 in., height 5 ft. 1½ in., and ground clearance is 11 in. The ground pressure is 6·3 lb. per square inch. Ancillary equipment is available for the Track-Marshall, including: central power take-off, rear-mounted belt pulley, heavy duty haulage winch, hydraulic bulldozer, driver's cab, electric lighting equipment, street plates, and 16 in. or 18 in. track plates.

DITCH-CLEARING ATTACHMENT FOR FORE-END LOADER

A ditch-clearing attachment that can easily be fitted to most types of tractor fore-end loader will be shown by Whitlock Bros., Limited, Great Yeldham, Essex. Operation of the ditcher is from the driver's seat, the motive power being supplied by the tractor hydraulic pump and controlled by a special two-way valve operating the fore-end loader and the excavating bucket. The attachment is suspended from the end of the fore-end loader, as Fig. 3 shows, and is self-centring when lowered into the trench. The excavating bucket is tapered to reduce suction drag when it is lifted from the trench, and it is fitted with an ejector plate which is fully automatic in action, travelling on rollers through the full length of the bucket to eject the spoil. The bucket is 2 ft. wide at the top and 1 ft. 5 in. wide at the base, and has a capacity of 7 cub. ft.

To operate the machine the tractor is driven up to and facing the ditch and the arms of the fore-end loader are lowered, dropping the bucket and sprag into the ditch. The sprag, which is fitted with detachable teeth, drops into the trench to form an anchor on which the bucket will close. The double-acting hydraulic ram is then operated, driving the bucket along the ditch to the sprag, which forms a front door to the bucket as it is lifted out prior to emptying. The fore-end loader is then raised and the tractor is backed away from the ditch. The hydraulic ram is operated in the reverse direction, causing the ejector plate to sweep through the full length of the bucket depositing the spoil on to the ground or into a trailer or lorry. Using the Ferguson "Hilift" the loading height is 7 ft.

TRACTO-SHOVEL AND ANGLEDOZER

On the stand of Mackay Industrial Equipment, Limited, Faggs-road, Feltham, Middlesex, will be a number of items suitable for heavy agricultural or public works duties. Among these is the Allis-Chalmers H.D. 9G Tracto-Shovel, illustrated in Fig. 4. This has a 100-h.p. engine and a 2½ cub. yard heaped capacity bucket. As with other Allis-Chalmers tractors all major components of the power train—engine, clutch, transmission, final drives and steering clutches—can be removed and replaced individually without disturbing adjacent components. Track rollers and idlers need lubricating only once in every thousand hours of operation.

Fig. 4 The Allis-Chalmers H.D.9G Tracto-Shovel has a 100-h.p. engine and the bucket has a capacity of 2½ cub. yard.

Fig. 5 The Fiat 55L develops 55 h.p. at 1,400 r.p.m., and the maximum drawbar pull of 12,400 lb. is obtained at 600 r.p.m. In the illustration it is shown fitted with a Mackay angledozer, the blade of which is 9 ft. 4½ in. long by 2 ft. 3 in. high.

The Fiat 55L illustrated in Fig. 5 is equipped with a Mackay hydraulic angledozer and a Boughton timber towing winch. The engine is a four-cylinder four-stroke direct-injection Fiat Diesel engine, developing 55 b.h.p. at 1,400 r.p.m. The maximum drawbar pull of 12,400 lb. is obtained at 600 r.p.m. There are five forward speeds varying from 1·4 to 5·2 m.p.h., and the speed in reverse gear is 1·8 m.p.h. Steering is by steering clutches and independent brakes, and the width of the standard track shoes is 17¾ in. The weight of the 55L is 11,130 lb., but ground pressure is only 4·67 lb. per square inch. The Mackay angledozer has a blade measuring 9 ft. 4½ in. wide by 2 ft. 3 in. high, and hydraulic pressure is obtained from a gear-type pump driven from the front of the engine.

MAINS-OPERATED ELECTRIC FENCER

Wolseley Engineering, Limited, Electric-avenue, Wilton, Birmingham, have produced an all-mains electric fencer in addition to their range of battery-operated fencers. It is primarily intended for use in connection with permanent or semi-permanent installations, such as piggeries where the animals are housed close to the main supply. Current at standard voltage is taken direct from a two-point plug to the unit, and a high tension lead is run out from the unit to the fence wire. No batteries or separate transformer are required. The output of the unit accords in all respects with the International Safety Regulations governing mains operated electric fencers. Also on the Wolseley stand will be a fencer barrow which has been designed to make moving batter-operated electric fences from one field to another an easier task. The barrow can be secured to the ground by spikes and then acts as a strainer and electric fencer mounting post; the spikes also ensure efficient earthing.

To be continued

B.T.C. CANALS

WATERWAYS DIVISION ANNOUNCES INITIAL PLANS

A separate Waterways Division was set up by the British Transport Commission in January this year to manage the canals and inland waterways under their control. As a result of the recent Report of the Board of Survey on Canals and Inland Waterways, the Commission have announced the following development plans, works and proposals. These are to be additional to the £2 million already spent on making good arrears of maintenance and on new works and facilities and, the Commission state, represent only a first small instalment of the major schemes which are necessary before the waterways can be of real value as part of the national transport system.

TRENT NAVIGATION

A £150,000 scheme is to be carried out in connection with the Trent waterway, which carries a substantial general cargo traffic from the Humber ports, largely to the Nottingham area. The scheme is designed to increase materially this traffic to Nottingham, and comprises three inter-related proposals.

(*a*) *Nottingham Depots.*—£90,000 is to be spent at the Trent Lane and Meadow Lane depots. A transit shed at Trent Lane, destroyed during the war, is to be replaced and additional cranage and other facilities provided. At Meadow Lane, the riverside frontage is to be extended to allow three additional berths, a new storage shed is to be built and new mobile cranes and other equipment provided.

The depot at Colwick, four miles downstream from Nottingham, and held by the Commission on lease, is to be vacated. It was used mainly for lightening the larger Trent craft—a need which has disappeared following work carried out at Newark, where a large modern lock has been built at a cost of over £70,000, and at Holme. The effect of these works was to enable craft of 200 tons to be navigated as far as Nottingham. Previously they could not pass beyond Colwick.

(*b*) *New Carrying Craft.*—Two new powered carrying craft of standard Trent size (150 tons) are to be purchased at an estimated cost of £22,000.

(*c*) *Wincolmlee Wharf* (*Hull*).—£40,000 is to be spent on re-equipping and expanding this depot, at which the sand and gravel which is the principal down river traffic on the Trent is processed and sold. The work is designed to achieve a better balance of up and down river traffic.

LEEDS AND LIVERPOOL CANAL

New workshops for all major engineering work in the northern district of British Transport Waterways' North Western Division are to be built at Wigan at a cost of £67,000. The installation will comprise a 430-ft. long steel-framed building, sub-divided to house shops, garage and slipway, on a 2-acre site which has an existing dry dock. When completed the workshops will be able to undertake repairs to the Commission's carrying craft and also the construction and repair of lock gates, bridges, etc., at present carried out at a number of small establishments throughout the district.

A £15,000 warehouse at Church, also on the Leeds and Liverpool Canal, has recently been completed to serve the increased needs of the textile machinery industry in this area. Machinery for export is canal-carried from Church to the Mersey ports, where it is loaded overside direct to sea-going ships.

Equipment at the new warehouse includes an overhead electric travelling crane with a gantry extension to the opposite bank of the canal.

AIRE AND CALDER NAVIGATION

A £350,000 traffic development scheme for this much-used waterway is at present being examined by the Commission.

The Aire and Calder Navigation is a main artery between Yorkshire's West Riding area and the ports of the Humber. It extends from Goole to Leeds (where it joins the Leeds and Liverpool Canal) and Wakefield (where it joins the Calder and Hebble Navigation), and is navigable by craft of 250 tons to Leeds and 170 tons to Wakefield.

The Commission's fleet in this area is at present served by eleven depots on the Aire and Calder and Calder and Hebble. The scheme now being examined is designed to eliminate uneconomic dispersal and dissipation of effort by providing modern terminal facilities at one central depot and to augment the fleet of powered carrying craft.

(*a*) *Knostrop Depot.*—It is proposed to build a £230,000 installation on a 28-acre waterside side at Knostrop, about 1¼ miles downstream from Leeds. On this site, which is linked by road with Leeds and West Riding towns, a single-storey storage/transit shed of 12,500 tons capacity will be erected on a 600-ft. long steel-piled wharf which will have eight berths for standard craft. Handling equipment will include mobile Diesel-electric cranes, fork lift trucks and shed trucks with pallets and boards. A service garage and repair shop for road vehicles will also enable waterway craft to be provided with fuel, stores and minor engine repairs.

(*b*) *Carrying Fleet.*—The concentration of activity at one modern depot at Knostrop will enable the Commission's carrying vessels to engage more fully in the substantial trade between the Humber and West Riding, and it is proposed to strengthen the fleet at a cost of £115,000 by purchasing nine new craft of standard 150-ton capacity, Diesel-engine driven, and by increasing the cargo capacity of four existing craft by modifications.

RIVER SEVERN

The important oil trade on the River Severn has led to the establishment of a big oil depot at Diglis, in the inland port of Worcester. Development work is continuing on reclaimed land made available by the Commission to the oil companies which have set up large storage and distribution centres there.

* * *

INDUSTRIAL TOOLS IN CANADA AND U.S.

Recent progress in the development of a wide range of industrial tools will be demonstrated during the next few months at two exhibitions on the American continent, the one at Montreal and the other in Chicago. The Canadian Industrial Tool and Equipment Show, previously known as the Montreal Industrial Tool and Equipment Show, is now in its sixth year and is due to be held in the Show Mart Building, Montreal, from Monday, October 24, to Friday, October 28, 1955. As in former years, this exhibition is being sponsored by the Foremen's Club of Montreal, 4585 Sherbrooke-street West, Montreal. It will be of a national character and the only one in Canada devoted exclusively to the display of tools for industrial plants. Invitations to attend the Show will be restricted to engineers and management personnel, and the general public will not be admitted.

The other exhibition is the eleventh biennial exposition of the American Society of Tool Engineers (A.S.T.E.), which is due to take place in the International Amphitheatre, Chicago, from Monday, March 19, to Friday, March 23, 1956. In addition to machine tools, the exposition will cover gauges and instruments, metal-forming equipment, and a variety of materials-handling and power-operated appliances. On previous occasions, a comprehensive range of diamond wheels and other diamond tools have been shown. A report from the British Consulate-General in Philadelphia, based on the 1954 exposition, emphasised the importance of these biennial exhibitions as a means of bringing British engineering equipment to the notice of potential buyers in the United States. In the opinion of the Board of Trade, firms in this country should preferably be represented in the United States market before taking part in the exhibitions. The address of the A.S.T.E. is 10,700 Puritan-avenue, Detroit 21, Michigan, U.S.A., but inquiries in Britain may be made to the Exhibitions and Fairs Branch, Board of Trade, Lacon House, London, W.C.1.

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TRANSATLANTIC TELEPHONE CABLE

Satisfactory Progress in Manufacture and Laying

Satisfactory progress is being made with the manufacture and laying of the transatlantic telephone cable, the technical features of which have already been described in ENGINEERING.*

At the beginning of June the loading of H.M. Telegraph Ship Monarch with 350 nautical miles of shore-end cable, made by the Simplex Wire and Cable Company, was begun at Newington, New Hampshire, and early this month 217 nautical miles of it will be laid from Clarenville, Newfoundland, and the seaward end buoyed. To ensure that the laying takes place on the pre-determined course, radio stations have been built on the mainland.

On the completion of this operation, the Monarch will return to this country where she will load about 1,130 nautical miles of deep-sea cable at the Erith works of Submarine Cables, Limited. This cable, together with the remaining 133 miles of the Simplex cable, will be joined to the buoyed end off Newfoundland and will then be laid in one piece to Rockhall Bank, about 500 nautical miles off the coast of Scotland. There it will be buoyed and in September the Monarch will lay the cable which will join it to Oban, thus completing this year's operations. Next year, the second main cable will be laid from Oban to Newfoundland, as will the cable between Newfoundland and Nova Scotia.

REPEATER INSTALLATION

The repeaters, which will be incorporated in the deep-sea portion of the cable at 37 nautical-mile intervals, are being manufactured by the Western Electric Company at Hillside, New Jersey, and are being flown to this country in specially-designed containers, elaborate precautions being taken to avoid damage in transit. When they have been spliced into the cable the joints will be examined by X-rays.

The land-based installations and terminal links are well under way on both sides of the Atlantic and the co-axial cable between Oban and Glasgow is being laid. The International Exchange in London is being extended and the special equipment necessary to facilitate connection with inland and continental subscribers is being manufactured.

A trench for the land section of the link between Clarenville and Sydney Mines in Nova Scotia is being excavated through difficult terrain by the Canadian Comstock Company, and 45 miles of the cable, which is of British design, has been delivered by the manufacturers, Southern United Cables, Limited. This cable will contain two-way repeaters manufactured by Standard Telephones and Cables, Limited. Of the 13 stations forming the micro-wave radio system across Canada seven have been built and the remainder will be completed in September. A similar link, consisting of six stations, is being built in the United States and will connect the cable system to the inland network.

* Vol. 178, page 638 (1954).

Labour Notes

NO VICTORY FOR ANYONE

Most railwaymen would conclude, writes Mr. J. S. Campbell, general secretary of the N.U.R., in last Friday's issue of the *Railway Review*, that the recent strike had not resulted in a victory for anyone. Neither the A.S.L.E.F. nor the Commission had emerged victorious and, Mr. Campbell agrees, nor had the N.U.R.

Although his own union was not directly concerned in the strike, it was most certainly affected by the outcome. Its loss was that of railwaymen generally. Co-operation between the unions had been dealt a severe blow and one from which recovery would take time. Healthy competition for members had been replaced by bitterness, which must be eradicated before its roots grew too deep.

He believed that when the bitterness had died down, railwaymen would express a heartfelt wish that their unions should get together and work with their former co-operation, which had brought such satisfactory results when the going was so hard.

No railwaymen, least of all locomotivemen, could afford to divide their strength or waste their energies. Modernisation presented a challenge and an opportunity.

RAILWAY NEGOTIATIONS

An agreement was reached in London on Thursday of last week between the British Transport Commission and representatives of the National Union of Railwaymen on pay claims put forward by the union in respect of certain grades of the railway staff other than enginemen.

These discussions arose from the increases awarded to engine drivers and motormen by Lord Justice Morris and the promise of the Commission, when the recent strike was ended, to consider such proposals for higher rewards for special skill and responsibility as the N.U.R. might put forward, provided that these claims were restricted to grades of similar status and pay range as those covered by the settlement respecting footplate crews.

As a result of the agreement, about 10,000 signalmen, foremen, and members of the communications and maintenance staff will receive increases ranging from 1*s*. to 3*s*. a week. The men affected by these pay concessions are those employed in the higher grades of the railway industry and their revised rates will be thereby adjusted in accordance with the new rates for drivers and motormen.

The highest-paid signalmen outside the London area, for example, will in future receive £9 13*s*. a week and this compares with the new rate of £9 18*s*. a week for drivers in the highest-paid category. These rates will maintain the difference of 5*s*. a week which existed before the strike, when their rates were £9 10*s*. and £9 15*s*., respectively. These increases, in respect of both drivers and other grades, will be payable as from June 15.

The last of the three parts of the strike settlement to be dealt with is the question of the mileage allowance for drivers and firemen engaged on runs of between 80 and 145 miles. Discussions on this matter between the Commission, the N.U.R. and the Associated Society of Locomotive Engineers and Firemen were due to be resumed last Wednesday. Substantial payments have been in force for some time for journeys of more than 145 miles.

AUTONOMY AN OBSTACLE

The view that any dispute between trade unions should be settled by the trade-union movement itself was expressed by Mr. Charles Geddes, the chairman of the Trades Union Congress, at the annual conference of the National Federation of Building Trades Operatives at Bournemouth last week.

Speaking as a fraternal delegate from the T.U.C., Mr. Geddes said that affiliated organisations should be obliged to allow the T.U.C. to intervene, when it could be shown definitely that the basis of a dispute was inter-union, and not only to intervene but to settle the difficulty. Such a proposal meant asking for powers for the T.U.C. that affiliated organisations had never been prepared to grant but, after all, the T.U.C. was in fact the trade-union movement.

When inter-union disputes involved workers in other unions and employers as parties to the dispute, then someone ought to be in a position to deal with the situation. If affiliated bodies had to sacrifice some of the autonomy they now guarded so closely, it was not too big a sacrifice to ask for in view of the difficulties which might face the trade-union movement.

Mr. Geddes said that he did not believe that it was a possibility, but that he did agree that unless the movement was prepared to accept its own obligations, and find its own solutions, there would be complete justification for the Government taking action.

People who believed that they could abolish strikes by legislation or otherwise were indulging in wishful thinking, but the impact of five months of industrial unrest could not be avoided.

DOCK STRIKE

Not even the absence of strike pay, or the knowledge that their leaders are divided, has been sufficient to curb the determination of the London stevedores to continue their strike action. The men's decision to persevere with their part of the stoppage, taken at a mass meeting in the East End on Monday, was a reversal of their decision of a week previously, when members of the striking union, the National Amalgamated Stevedores and Dockers, accepted a recommendation to return to work.

The strike, which is now in its sixth week, was begun on May 23 in support of a claim for the recognition of the N.A.S.D. as a fully-negotiating body, in addition to the Transport and General Workers' Union, in the dock industry at the northern ports. The N.A.S.D. has always received full recognition so far as the Port of London is concerned.

On Monday, it was reported that the total number of men on strike at the affected ports, including London, amounted to 18,386. Of the ships lying at these ports, 159 were being fully worked, 120 partly worked, and 168 were idle.

At Hull, a substantial number of strikers have drifted back during the past few days and at Rochester, where about 90 men had been idle, there was a complete resumption of work on Monday.

T.U.C. ASSISTANCE

There have been many cross currents and divided counsels during the course of the dispute, but the basis of the trouble is an argument between the T.G.W.U. and the N.A.S.D. over membership of the unions at Liverpool, Birkenhead, Manchester and Hull, and this is the principal obstacle to the recognition of the latter union by employees in these ports.

Last Friday, the dispute committee of the T.U.C. began an investigation of the whole matter, in an endeavour to heal the breach between the unions, and heard complaints by the T.G.W.U. against the N.A.S.D. On Tuesday, the committee met again and is understood to have then heard the other union's side of the matter. The committee, which has Mr. Charles Geddes as its chairman, was due to present its report to a full meeting of the T.U.C. General Council on Wednesday.

Mr. R. Barrett, the general secretary of the N.A.S.D., recently resigned from that position and stated at the week-end that, throughout the dispute, he had advised the stevedores to resume work. At a mass meeting in Manchester on Sunday, Mr. W. Newman, the union's acting general secretary, also advised the men to return. He said the union was likely to gain as much by that course as by a continuance of strike action.

Mr. Newman reminded his hearers that the suspension of the N.A.S.D. from the T.U.C. had been lifted and he took the view that if the strike were to be continued the men must be prepared to struggle on for another five weeks at the least. Even if there were a general return to work, the union's leaders would carry on the fight for recognition with the same determination as hitherto.

PENSIONS IN ENGINEERING

Correspondence has been exchanged between the Confederation of Shipbuilding and Engineering Unions and the Engineering and Allied Employers' National Federation concerning the unions' request that discussions should be begun between these organisations regarding the introduction of a national pension scheme for employees in the engineering group of industries.

According to a reference to this matter in the June issue of the *Transport and General Workers' Record*, the official journal of the Transport and General Workers' Union, the employers' Federation has taken the view that it has no mandate from its constituent bodies to deal with such a subject and that the question of pension schemes is a matter for the consideration of individual firms.

The employers' Federation also pointed out that the terms of any pension scheme which might be introduced on a national basis, for the industries as a whole, might well be directly opposed to the provisions of existing local schemes, which vary considerably as between one firm and another.

The *Record* comments that there are not so many of these individual schemes in existence and informs its readers that the Confederation has decided to press for discussions between itself and the employers' Federation to be begun on this problem on a national basis.

POST OFFICE PAY AWARD

About 15,000 technical employees of the Post Office are expected to benefit from an award by the Civil Service Arbitration Tribunal, the details of which were published on June 13.

For the senior of the five grades employed on certain types of engineering work, principally in connection with the construction and maintenance of equipment required for the telephone and telegraph services, the Tribunal fixed the rate for operatives employed in the London area at £8 6*s*. a week, rising by eight increments to £11 10*s*. a week. The Tribunal decided that the scale for provincial employees shall be settled by negotiation between the parties.

All increases will be ante-dated to January 1 last.

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NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

SHEFFIELD
Annual General Meeting. Sheffield Branch. Royal Victoria Hotel, Sheffield. Mon., July 4, 7.30 p.m.

Institution of Highway Engineers

LONDON
Film on "Highways for To-morrow." Annual General Meeting. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Fri., July 1, 5.30 p.m.

Royal Sanitary Institute

DURHAM
Various papers, including "The Durham Towns: Their Economic and Social Significance," by A. V. Williams. Durham Sessional Meeting. Shire Hall, Durham. Fri., July 1, 10 a.m.

Society of Chemical Industry

BIRMINGHAM
Annual General Meeting. Various papers, visits and excursions. Held under the auspices of the Birmingham and Midland Section. Grand Hotel, Birmingham. Mon., July 11, to Sat., July 16.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Institution of Highway Engineers, 47 Victoria-street, London, S.W.1. (ABBey 3891.)
Royal Sanitary Institute, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)
Society of Chemical Industry, 56 Victoria-street, London, S.W.1. (VICtoria 5215.)